THE

ENGINEERING MAGAZINE

VOL. XII. NOVEMBER, 1896. NO. 2.

THE INDUSTRIAL EFFECTS OF FINANCIAL ISOLATION.

By Logan G. McPherson.

THE red volumes issued by the department of State, entitled "Commercial Relations of the United States with Foreign Countries," show, with abundance of statistics and detail, that there is not a country upon earth that the United States does not export to or import from. In broad channels there is the surge of commerce between our harbors and the ports of Europe: along lesser veins and arteries the fruits of our fields and factories flow to remote corners of Asia and Africa, whence come to us rare foods and fabrics. There is this ebb and flow of commerce between the nations, because one people produce that which another people want. We buy what we need, and sell to others what they need.

The most prosperous country—the country which can support in comfort the largest population in proportion to its area, and draw to its shores the largest volume of the world's natural and potential wealth—is that which can best supply the demand for those manufactured articles whose production requires the exercise of skill and labor, and whose value, therefore, includes the largest possible component portion of labor cost. The production of such articles means the establishment of manufacturing and industrial concerns involving the employment of the engineer and technician for their installation and management, for the construction and control of the vast net-work of land and water ways which they require, and for the design and supervision of the almost infinite extent of public and private works connected with them, or with the life and health of the population which they support. The engineer, therefore, using the term in its broadest sense, is vitally interested in every question affecting the commerce of the country. No stronger illustration is needed than the sudden con-

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traction of engineering enterprise during the past four years of financial agitation. Should the same unfortunate conditions prevail for another four years, the results, to the engineer, could be nothing but stagnation and disaster.

This desire to sell and this desire to buy link the peoples of the earth in bands of mutual advantage that have been forming with strengthening clasp for more than three thousand years. A current map of the vessel routes of the world is a lace-work of lines that cover the ocean, and inland maps are likewise laced with lines that mark the railways. As commerce has increased, civilization has increased. Indeed, "no general and permanent progress of civilization is possible, unless it is based on economic improvement." The increase of inland commerce in the middle ages led to good roads and strong bridges; to persistent attacks upon the robber barons and the outlaws; to the extension of a uniform system of law and its enforcement; to the broadening of interests beyond the narrow limits of the immediate neighborhood; and, not least, tended constantly to bring the separate currencies of the numerous petty States into a definite relation approaching uniformity. "The introduction of better conditions in these respects was almost in itself the transformation of the medieval into the modern," and the ceaseless war of the medieval merchants against barbarism is akin to the war which commerce, consciously or unconsciously, through its participants, wages against barbarism at all times and in all places. The food, clothing, and implements, the articles of use and ornament, that comprise the merchants' wares contribute to the comfort and the fullness of the lives of those into whose possession they come, and those concerned in the production and distribution of the wares of commerce receive a beneficent training and discipline in the virtues of concentration, endurance, foresight, and honesty. The ministering to others' needs necessarily based upon an apprehension of others' wants leads to that breadth of mind and character which is given by the appreciation of the customs and habits that have grown around other peoples and the extent to which they form their lives. And therefore is needed no argument to sustain the proposition that every improvement of whatever nature that tends to develop and increase the commerce of the world is a benefit to all concerned in that commerce.

It is a matter of history that, whenever people have progressed beyond mere barter to constant and considerable exchanges, it became necessary for them to use some commodity as money; and, as the members of one group progressed to the exchange of commodities with the members of another group, there was the tendency to the use by both groups of the same commodity as money. This tendency,

increasing as the exchange became general and interracial, led to the use among the different races of the same commodity as money.

Because of their peculiar fitness, gold and silver supplanted other commodities for this purpose. They were so used by the Caucasian races before the beginning of the Christian era; their use increased and extended during the development of medieval commerce; and they form the currency, or are the recognized basis of the currency, of every civilized or semi-civilized nation of the earth to-day. Because of its possessing greater value in less bulk and greater stability of value, gold has tended among the nations whose commerce is the most highly developed to supplant silver as the standard of value and as the recognized basis of the paper representatives of value, comprising circulating notes, promissory notes, drafts, and bills of exchange.

As the adoption of the most valuable commodity as a means of exchange and the standard of value is coincident with the increase in the production and distribution of commodities, it follows that the most valuable means of exchange is used in those communities that are the best fed, the best clothed, the best housed. That is, the use of the most valuable means of exchange is characteristic of an advanced civilization. It cannot be denied that England, France, Germany, and the United States, in which the gold standard is dominant, are in the forefront of civilization, while the barbarism of China is indicated by the fact that its four hundred million inhabitants, in their daily transactions, use almost exclusively the copper "cash," one thousand of which are about equal in value to one Mexican dollar.

It is evident that, if the monetary systems of any two countries were based upon the same standard of value, and if their coins were of the same weight and fineness, the exchange of commodities between them would involve no complications, in so far as the kind of money to be paid in each transaction is concerned. Buyer and seller would have to consider only the amount of money. Approximating such a nature are the transactions between the United States and Canada, the dollars of one country being equal to the dollars of the other.

When the monetary systems of two countries are based upon the same metal as the standard of value, but the coins of one country do not correspond in weight and fineness to the coins of the other country, the buyer in one country and the seller in the other must consider the value of the money of the one country as measured by its value in the money of the other country. Of such a nature are the transactions between England and the United States, the value of the dollars of the one country bearing a fixed ratio to the pounds of the other. When the monetary systems of two countries are based upon different metals, the estimation of the value of the money of one country as measured

by the value of the money of the other country would not be more difficult than if the money of the two countries were based upon the same metal, provided the values of the different metals bore a fixed and constant ratio to each other. But this relation does not obtain between the currencies of any two countries that are based upon different metals as the standard of value. The gold coin of a gold-standard country is but merchandise in a country having a silver standard, and the silver coin of a silver-standard country is but merchandise in a country having the gold standard. And gold and silver, particularly silver, are subject to fluctuations in value, the same as other merchandise is subject to fluctuations in value. In each transaction between a buyer in a gold-standard country and a seller in a silver-standard country, or *vice versa*, must be taken into consideration the amount of silver which the gold of one country will purchase, or the amount of gold which the silver of the other country will purchase. This would not be difficult if, in each transaction, the exchange of gold or silver and the exchange of merchandise were instantaneous. But the seller must always consider what value the money to be paid him will possess at the time when he receives it. Upon the accuracy of his foresight depends his gain or loss by reason of the fluctuation in value which the money of payment may undergo in the intervening time, and it follows that, the greater the possibility of fluctuation in the value of the money of a country, the more hazardous is the conduct of business with that country, and the more does such business partake of speculation. If the currency of a country is composed of circulating notes more or less depreciated, rising and falling in value as measured by coins of one or another metal that may nominally be the standard of value in that country, in each transaction must be calculated the value of the depreciated currency in the coin of the country, and the value of that coin in the coin of the other country. The fluctuations of the paper currency as measured by the coin of the issuing country, and the fluctuations of that coin as measured by the coin of the other country, by greatly increasing the risks of commerce with the country having the depreciated paper currency, tend to give that commerce the character of gambling, and to prevent merchants from engaging in it who can dispose of their wares elsewhere.

Were coin actually transferred from one country to another in payment for every transfer of merchandise, vast quantities of coin would always be in transit, and, during the period of transit, commerce would be deprived of its use as money. With the growth of international commerce, has, therefore, developed an economy in the use of coin similar to the economy in the use of coin in the domestic commerce of a country having a developed banking system.

As in domestic commerce the use of checks and drafts largely obviates the shipment of money, so in foreign commerce the use of bills of exchange largely obviates the shipment of money.

The great volume of international commerce causes a great number of bills of exchange to be continually offered in every large shipping city, and they are bought and sold by dealers in bills of exchange, who are alert and vigilant in watching the fluctuating values of the moneys of different countries. And these dealers in bills of exchange are on the alert, not only to avoid loss, but to obtain profit because of these fluctuations. Their charges for handling bills of exchange between two countries having the gold standard, such as the United States and England, cannot, as a rule, be much greater than the cost of shipment of the actual money, plus the interest for the time it is out of service. But, for the handling of bills of exchange drawn between countries one or both of which may have a fluctuating currency, they charge sufficient to protect themselves from loss by reason of possible or probable fluctuations.

In a previous paragraph it has been pointed out that a country having a fluctuating currency is at a disadvantage in obtaining imports. It can readily be perceived that it is likewise at a disadvantage in disposing of its exports. The prices of all similar products of exporting countries are subject to competition in the countries of import. This fact alone places the merchants of the country having a fluctuating currency under a tremendous disadvantage, as compared with the merchants of countries having a stable currency. But there is the further fact that, largely because of the smaller risk in handling bills of exchange drawn upon countries having a stable standard, such bills are always more readily to be obtained than bills drawn upon countries having a fluctuating standard. Merchants of the latter countries, therefore, often have to pay a heavy premium to obtain bills of exchange at all, their facility for the disposition of their products being often thereby further decreased. It follows, therefore, that, if one standard of value is dominant among the countries most largely engaged in international commerce, any country having a currency based upon a different and fluctuating standard is hampered in its efforts to continue in such commerce. As gold has become the dominant standard of value of the great commercial powers of Great Britain, France, Germany, and the United States, it follows that, should any of these countries—the United States, for example—adopt another standard, it would place its merchants at such a disadvantage that, under the stress of modern competition, the exports of the country would tend to decrease instead of to increase.

As the capacity of the United States for production is at present

largely in excess of its capacity for consumption, and as its future prosperity depends largely upon the increase of its exports, it follows that such result would militate decidedly against the interests of the entire nation, and particularly against the interests of those immediately concerned in the erection and maintenance of the structures used directly or indirectly in the production and transportation of such exports. As the value of silver is subject to great fluctuation, the adoption of the silver basis for its currency would bring upon the United States the evils incident to a fluctuating standard. Its import and export trade would be hampered and restricted, and our travellers, who annually visit other countries in greater numbers, would be subject to inconvenience and loss in obtaining money current in those countries. The pound sterling of Great Britain is the most universally recognized unit of value in the world. There is not an important mercantile establishment in the Occident or the Orient that does not know its value at all times. The franc of France and the mark of Germany are likewise of definite and recognized value in all places. This does not hold true of any silver coin issued by any government on earth. Shall the United States strengthen its position among the foremost nations of the world by maintaining the standard of the gold dollar, or shall it abandon its position in the vanguard by adopting a varying dollar of silver?

There seems but one reply possible to this question. That thousands, perhaps millions, of the people now living in our country think that we can achieve prosperity under a monetary system chosen without regard to the international standard of value; nay, more, that by many it should be considered servile for the United States to pay any regard to that standard, and an indication of our glorious independence to ignore it,—seems inexplicable. But the reason for such a feeling can, in part at least, be explained, if it be considered that the industrial development that began on the eastern shores of the great European sea has not proceeded in unbroken cycles, nor, until within recent years, has the true meaning of that development been perceived.

In the dawn of history the contact of tribes was principally that of conflict. The conquering race reduced the vanquished to slavery, and the result of its efforts was obtained by scourge. When the victor could no longer hold the vanquished in the bondsman's leash, he still levied tribute out of all proportion to our modern sense of right. Throughout all history there has been outrageous levy by kings, popes, and emperors, upon the people of other nations. When any group of people has made successful rebellion against such servitude, it has been said to have established its independence, and independence has become the watchword and the cry of patriotism.

In the last century the American colonies won a wonderful fight against their British oppressors, and that superb struggle has been so lauded in our schools and in our prints that to many it seems that independence includes contempt of all the institutions of other lands than our own. Therefore, when it is urged that we cannot prosper under a standard of value different from that of the great European nations, they think an attempt is being made to degrade us to a condition approaching that from which we escaped over one hundred years ago.

All mankind has been slow to learn that civilization depends upon industrial coöperation, and not upon industrial antagonism. International commerce that mingles the products of climes and countries is but the highest expression of that division of labor which began when there was the exchange of baskets and pots between the weavers of bands and the moulders of clay. Through the centuries, as that commerce has increased, there has been emulation between the nations in the adoption of methods that simplify, facilitate, and make less hazardous its processes. The mariner's compass is on every vessel; one maritime code of signals is known to all sailors. Compass and code that guide and guard the vessels laden with products and passengers are, like bills of exchange and the standard of value upon which they are based, but tools that ease the conduct of commerce. No nation can maintain a foremost rank among the commercial nations of the world with an isolated standard, any more than its marine would flourish if it attempted to guide its ships by the stars and to use a code of signals peculiar to itself.

It is often claimed by advocates of the silver standard and by some bimetallists that the countries having a silver standard are at an advantage in exporting their products in competition with other countries, because, as wages are paid in these countries in silver, the cost of production is less than in countries where wages are paid in gold. But it must be reflected that exports to and imports from the great commercial powers are bought and sold upon the gold standard, whatever may be the domestic standard of another country. For example, an English merchant importing wheat from India calculates how many rupees he can buy with a pound, and how much wheat he can buy with these rupees. If wheat from India can be sold in Liverpool at less than wheat from America, regardless of the fluctuations of silver in the English market, the American producer is being worsted in competition with the Indian producer not because of the silver standard in India, but because the absolute advantages of the Indian producer in production and transportation outweigh the disadvantages of the silver standard. The Hindoo works for little, and can purchase

but little. India is not, in proportion to its population, a great market for the world's products. A nation is commercially great and is in the highest sense prosperous when its commerce comprises vast quantities of varied merchandise. And this stage is reached only when its members progress to familiarity with and need for articles that the Indian laborers do not know the use of. In the generations to come, when from their present perceptible awakening the Hindoos have reached a higher development, they will not be content with the crude food, clothing, and habitations that now satisfy them. When that time comes, there will be the ebb and flow of commerce, profitable alike to them and to the nations with which they deal, and they will need a more stable and more valuable standard than silver, as surely as the Japanese, whose progress has been so marked, are approaching the standard of gold. Between the Japanese and the west is the Cossack, who has found himself hampered by the silver standard; and further sustaining the immediate argument is the fact that over ninety per cent. of the world's commerce is between the great powers adhering to the gold standard, whose citizens are better housed, better clothed, better fed, and more appreciative of the higher arts than are any of the other races of men.

In conclusion, attention is again directed to the consideration that appeals with overwhelming force to the constituency of this magazine. The development of the resources of a country depends upon the building of railways and bridges, the opening of mines, the erection of mills and elevators. The inception and prosecution of these enterprises are made possible only by the use of enormous capital which flows readily into investments promising sure returns, but shrinks from outlay in directions whence returns are uncertain, as they must be if the currency rises and falls in value. The natural resources of the United States are of unquestioned magnitude and variety, but the accumulated capital of other countries which is needed for their exploitation, and which in times past has come to us liberally, now lies in the vaults of Europe. With every intimation that our currency may drop to the silver basis, that capital is withdrawn by the million. Should the November elections not overwhelmingly and undeniably indicate that the American people pledge themselves to maintain the stable standard of gold, the blight that will come upon our industries will fall with heavy and smiting force upon the engineers, whose welfare almost absolutely depends upon the prosperity of industrial enterprises. These gentlemen, therefore, not only have the general interest of patriotism in exerting every influence to roll back the tide of silver, but the immediate interest that particularly affects themselves and those dependent upon them.

LUXURY AS A STIMULUS TO RAILROAD TRAVEL.

By H. G. Prout.

LAST month we saw that, whereas every inhabitant of the United States took 5½ journeys by rail in 1882, he took 7¼ in 1895,—that is, he travelled 31 per cent. oftener in the latter year. We saw that the total travel was equivalent to one person going 7,688,500,000 miles in 1882 and 12,188,500,000 in 1895. We saw that the average man travelled 146.7 miles in 1882 and 174.1 in 1895. While the population increased about 33 per cent., the total passenger movement, as measured by the passenger-mile unit, increased about 60 per cent. We considered somewhat the influence of fast trains in increasing passenger travel. The obvious growth of comfort, of beauty, and even of luxury in cars and stations suggests that these may be important influences in inducing people to move about by rail.

I remember many railroad journeys which, it seems to me, one could take for the pleasure of the journey, apart from the wish or the need to get somewhere. I remember sitting by the window of a beautifully-appointed dining-car and eating a comfortable dinner while looking out on the noble Hudson; and smoking at ease in a "café-car" while gliding through the Mohawk valley; and lounging in an observation-car up the valley of the Juniata and over the Alleghenies; and winding down the New River valley where more than sixty per cent. of the line is on curves, and where splendid pictures open up in swift and incessant variety. I remember, too, charming journeys when, seated in a beautifully-upholstered, first-class compartment, I have seen the English farms and villages and parks and forests slip past. Remembering all this, I am led to think that many a man is tempted to travel merely by the luxury of modern travel.

But what is luxury? The Century Dictionary says that luxury "is that which is delightful to the senses, the feelings, etc., especially that which gratifies a nice and fastidious taste." Webster says that it is "anything which pleases the senses, and is also difficult and costly to obtain." In this light I sometimes doubt if anyone has tried the experiment of making railroad travel luxurious on a sufficient scale or for a long enough time to know much of its effect in increasing travel. There has been a considerable display of that which is costly and difficult to obtain, but less of that which gratifies a nice and fastidious taste. Indeed, a very plain and ordinary taste will still often find

more to offend it than to please it in a journey of twenty-four hours on an average sleeping-car. One need not be nice and fastidious to be shocked by the unfitness, tawdriness, and vulgarity of a good deal that he must still see and endure in many a railroad journey. Taste in car-decoration and sense in car-furnishing have grown immensely in the last ten years, and the average "sleeper," built within, say, three years, has been purged of the worst features of its ancestors; but, if less pretentious in appearance, it is still deficient in some of the essentials of actual comfort. Up to within a few years the men who sought to make the sleeping-car attractive to the public by displays of beauty and luxury seem to have been governed a good deal by the standards of the western millionaire who had just built for himself a palace. His wife was shocked by the stains on the new carpet. "Don't mind that," he said; "it is easier for me to buy carpets than to look where I spit." The barbaric desire to show folks how rich you are corrupted the taste of the designer of the car and of its furniture. To him luxury meant that which is costly and difficult to procure, not that which is fit for its uses or pleasing to a nice and fastidious taste. Late designs show a tendency towards simplicity and utility, but the influence of untutored wealth is still predominant. It makes the cars cost too much to build and maintain; it threatens public health by providing lodgment for germs; and it corrupts public taste.

At the Atlanta Exposition the beautiful Pullman train which had been shown at the World's Fair at Chicago was exhibited. My colleagues on the jury of awards wished to give to this a gold medal, an award which I opposed somewhat, but not at all strenuously, for I did not feel sure that I was right. To me that train was a beautiful and indeed a wonderful exhibition of the skill of the architect, the cabinet-maker, the decorator, the upholsterer, and other craftsmen, but as a railroad train it was an absurdity. Its influence was bad, and it deserved rebuke rather than reward. However, perhaps I am a crank. At any rate, the train got the gold medal.

It is reasonable to suppose that handsome surroundings which gratify the eye and soothe the mind, and comforts which rest the body, attract custom to a railroad; that they not only draw passengers from rival roads which offer less that pleases the fastidious appetite and taste, but actually induce people to travel for the pleasure of traveling, or, at least, do not discourage them. It may be interesting to look a little at what the railroads have done and are doing to make travel pleasant.

We may properly begin at the station. In the great cities some splendid edifices have been built in recent years, with vast rooms and

a wealth of decoration. The new Union station at St. Louis, for example, has a frontage of 606 feet and an average depth of 80 feet. Two of its floors aggregate 70,000 square feet in area, entirely devoted to the accommodation and comfort of travelers. Each of these has a great hall 76 feet × 120 feet, and the hall on the second floor has a barrel-vaulted ceiling 65 feet high. There are special rooms for women and for men, restaurants, a private dining-room, and all the offices necessary for the administration of the business. The details of finish are beautiful, often sumptuous, and very costly. The new station of the Illinois Central at Chicago has a waiting-room 100 feet × 150 feet and 75 feet high. The great vaulted ceiling, like that of the St. Louis station, is a single arched span without intervening columns. There are other recent notable stations in Chicago, and in the east we find the new Reading station in Philadelphia, the enlarged and improved Pennsylvania station, and the new Union station in Boston. These are a few examples of the most important and costly of recent stations. They illustrate much that is characteristic in the latest station architecture, and they strengthen the opinion that we are passing through a period of profuse expenditure for spectacular effect, and that a truly civilized architecture must give more recognition to the beauty of adaptation. We should expect in the next decade or two to see comfort, convenience, economy, and beauty of proportion, rather than beauty of space and lavish ornament, prevail in the design of stations. The most common defects of the great city stations are the use of the waiting-rooms for other purposes than waiting; too little provision for dealing with crowds at the ticket windows, and cramped passages to the trains. The comfort of those who wait is destroyed by the throng, and the convenience of the far greater number who do not wish to wait is sacrificed by crowding them into large spaces and suddenly disgorging them through narrow doors and gates. The common English practice is simpler, cheaper, and far more comfortable and convenient. You find there ample ticket windows opening on broad passages leading directly to the train shed, and passengers do not need to pass through the waiting-rooms at all. Having secured your ticket, you can go at your leisure and ease direct to your train. If you must wait, you find waiting-rooms, which are small and quiet, being only waiting-rooms and not passage ways or offices or bazaars. If, then, we consider American station architecture as a means of attracting reasonable people to the railroad, it seems to have been developed on the wrong lines.

In other elements of comfort and utility our stations are not notably successful. The restaurants, as compared with those of England and France, are either inferior in elegance and comfort, or they

are dear. The toilet and sanitary arrangements, as compared with those of England, are inferior in completeness and cleanliness.

Of country stations little that is good can be said. Around a few of the great cities some charming ones may be found,—pretty buildings with walks and drives and flowers that tempt one to turn aside from the highway, and that may even lead one to think favorably of a railroad journey. But the immense majority of the country stations are grossly utilitarian and without the least hint of nice and fastidious taste ; often they are simply squalid.

But let us pass to the train. Here, at least, we may hope to find comfort, and, in extreme cases, luxury ; and, if we compare the present with the past, we shall not be disappointed. Those who saw the old Camden & Amboy cars of 1831 which the Pennsylvania Railroad took to the World's Fair in 1893 will grant this. The low roofs, the minute windows, the straight, narrow, hard benches would make a journey a penance to be endured if necessary, but never to be undertaken willingly. This car long ago developed into what is now the typical day-coach, providing a reasonable cubic space for each traveler, with large and well-glazed windows, and with clear-story ventilators ; but the seats improved only very slowly. The necessity for reversing kept the back straight and the seat horizontal ; the desire to economize space kept it shallow. In course of time the reclining-chair was developed, and this has become a necessary feature on western railroads ; but the reclining-chair is not economical of space, and a few years ago Mr. Forney undertook to design a seat which should be as comfortable as the reclining-chair and yet fulfill all the requirements of the ordinary day-coach seat. He went at the job in a scientific way, and evolved the Forney seat with its deep cushion, whose forward edge is raised automatically when the back is reversed, and whose high back is designed to fit the human figure. While the use of this seat is by no means universal, it has modified the designs of other makers, and has shown them how to make a comfortable car-seat.

The chances are that we shall find the day-coach more comfortably lighted, heated, and ventilated than the average sleeping-car, and this is especially true in respect of lighting and ventilation. Of the 36,000 passenger-equipment cars of the United States (including baggage, mail, and express) 9,400 are now equipped with the Pintsch system of lighting by compressed oil gas. Some hundreds are fitted for burning compressed city gas, a few with the dry carbureter system of gasoline lighting, and a very few are lighted by electricity. The rest are lighted only by kerosene lamps ; but in the day-coach one can usually read fair print with some comfort, while in the sleeping-

car he very often cannot read without abusing his eyes. There are certain special reasons why the sleeping-cars, as a rule, are not so well lighted as the average day-coach. It has been somewhat difficult to extend to them the system of lighting by compressed oil gas, for the reason that any one car must be ready to run over a considerable number of railroads, and gasing plants have not been frequent enough to make it possible to recharge at convenient intervals. This difficulty has now nearly disappeared. The method of lighting by compressed city gas is confined practically to one railroad system, and there are several particulars in which it is inferior to the compressed oil gas system, and for this reason it has not spread to other roads. Lighting by electricity is still a costly luxury for any class of cars. It is used only on a few "limited" trains designed to be especially attractive, except on the Chesapeake & Ohio, where many cars are lighted by electricity from storage-batteries, in ordinary service. Electric lighting must still be regarded as too costly to use, except for advertising purposes. Such, briefly, are the reasons why the average sleeping-car is still very indifferently lighted.

It is not so well ventilated as the average day-coach, because the doors are not so often opened, because the flow of air through the car from the door is obstructed by the special rooms built at either end of the car, and because the vestibules cut off the inflow of fresh air when the doors are open. In other words, the day-coaches get more frequent change of air accidentally,—not because they have any superior system of ventilation. In fact, no system of ventilation by which an ample supply of fresh air shall be provided in any car, regardless of the opening or the closing of the end doors, regardless of the direction and velocity of the wind, and regardless of the speed of the car through space, has yet been developed in any country. In the matter of heating we are better off. The methods now in common use are probably adequate, if used with reasonable care on the part of the trainmen On the whole, the modern day-coach seems to be about as comfortable as it can be made, if it is not crowded.

In the sleeping-car one is sure of more room than in the day-coach, and that is one of the greatest elements of comfort in a railroad journey. The seats are sufficiently well cushioned and are of ample proportions, and of the beds no one need complain. But luxury, and even comfort, break down when one goes to the dressing-room. The most enthusiastic person could hardly claim that he can make his toilet luxuriously on a sleeping-car. To stand in a crowded corner, subject to the observation of passers-by; to wash one's face in a basin which another man has just used for cleaning his teeth; to dry one's self on a scrap of a towel smelling of the laundry,—is a very poor substitute for

the comfortable temperature, the brisk shower, and the big, sweet towels which almost any man can have in his own bath-room.

In this brief review of the ordinary conditions of railroad travel we must not neglect the dining-car. With its fresh linen and bright glass, its flowers and copious bill of fare, this institution has a superficial attractiveness, and has done much to divest travel of its terrors. It is an immense advance over the hasty and precarious meal at the wayside eating-station. It has elevated taste, and has helped to improve our national cooking. Within three or four years it has invaded England, and mitigates the longest journeys there, by both first and third classes, —for third-class dining-cars are now run, and give excellent service. But I am disposed to think that the dining-car service is not precisely what it will be a few years hence. The man who knows how to eat much prefers fewer dishes, better cooked ; and we may reasonably expect sometime to be able to order from the card a steak or chop or bird, specially cooked, and to get with it a mealy potato boiled in its jacket, and a mug of ale. Some day we shall be emancipated from the twenty kinds of things with fine names, all tepid and all tasting much alike. In fact, the dining-car, with all its merits, is not the perfect flower of our civilization. It is very costly to operate, and is an incomplete solution of the problem of feeding passengers. There are places in this country where one can get a simple and comfortable meal at a country station, and enjoy the rest and change of stopping to eat. Furthermore, I have yet to hear any sufficient reason why cheap and wholesome basket-lunches should not be put aboard to order, at certain stations, as is so commonly done in England. I wish someone would try the experiment here,—well and on a large scale. Some roads have begun the practice of serving light lunches *à la carte* in the dining-car, and one or two serve all meals this way on certain trains. One road, at least, serves a "train lunch"; that is, one may be served in any car of the train with a lunch from the dining-car.

So far I have written of the average conditions under which the American citizen must travel. There are conditions considerably better calculated to induce him to move about, which may be found on some trains in some regions. For instance, most of that which is least agreeable in the sleeping-car is avoided in the compartment cars now run regularly on a few railroads and a few trains. There one may secure one of the two berths in a compartment, or both of them, at the same price that he must pay in the open car. He has comfortable toilet arrangements in the compartment, with hot and cold water. If he has an electric reading-lamp in his berth, and can go forward to a "café-car" to smoke and drink a cocktail and see his fellow-passengers, he ought to feel pretty well satisfied with what he

gets for his money. The observation-car at the rear of the train, with moveable wicker chairs, and the library-car, with writing-desks, papers, magazines, and books, are not very unusual now. More exceptional trains are those which carry a stenographer and type-writer, a lady's maid and a barber, and a bath-room.

All these exceptional conditions, however, are still so unusual that they can have but a moderate effect on the volume of travel and the revenues of the railroads. The great and serious results are produced by the average conditions. These, while hardly coming within the definitions of luxury, are so comfortable that a person of ordinary health and energy, with some enterprise of spirit and a well-developed curiosity, can often find in a railroad journey positive enjoyment. I have endeavored to suggest some particulars in which travel can be made still more enjoyable, and that generally without expense to the railroad companies. Some of the improvements which seem possible would, indeed, diminish first-cost, if not working expenses; for, after all, it is true that that which gratifies a nice and fastidious taste is not usually that which is costly and difficult to obtain.

THE CANTILEVER AS APPLIED TO BUILDING CONSTRUCTION.

By John Beverley Robinson.

IT is commonly said, in reply to demands for the invention of a new style of architecture, that it is impossible that such a thing should be invented; that styles of architecture must develop slowly from present conditions by paths that we can hardly anticipate.

No doubt that this is most true; that, like everything else, architectural style and other styles—of dress, of ornament, of music—must evolve, as modern thought and investigation have settled, from what now is, as what now is has evolved from what was.

Nevertheless, laying aside all dogmatism, placing no undue faith in our own conclusions, it may be of interest to observe as well as we may the tendencies of architectural design at the moment, and to forecast the possibilities at least of the future; as the foot-traveller through mountain-lands strives to forecast the course of the path before him, whether it will wind on this side or on that of the opposite peak, judging from the topography of the country over which he has just passed, and from the black furrows in the wooded hills, and the sharp gaps in the foliage ridge against the sky, that his eye may be able to discern.

And, first, as to what constitutes an architectural style. In popular opinion such is but a certain character of ornament, equally applicable to any building at will. That a building may be Greek, or Moorish, or Gothic, at pleasure, or made over into all by turns, by recarving and repainting,—this is the common view. To some extent, too, this view is justified by the way that even architects have of fitting up rooms in all kinds of styles,—Renaissance, Indian, Japanese, Persian, Pompeian, Flemish, Elizabethan,—giving much ground for the opinion that architectural style is a matter of mere whim.

Partly, too, the nomenclature of the revival of antique culture is responsible for this opinion. We have all been taught to connect the word style with certain conventional schemes of ornament by which ancient designs were crudely catalogued,—Doric, Ionic, and Corinthian,—ignoring the freedom with which the live Greek artist modified and combined them.

In the *Architectural Record* for the third quarter of 1894 an article by Montgomery Schuyler was published, giving illustrations of the great cantilever bridges, and noting the possibility that the cantilever might be used in architecture. I am indebted partly, but not altogether, to that article for the first conception of the idea that I have tried to develop.

TEMPLE OF NEPTUNE AT PAESTUM.
A Type of Greek Lintelled Architecture.

A more judicious use of the word "style," applied to architecture, places fundamentals first, and regards the ornament as growing out of the system of construction employed. In all minor arts, too, the same principle is found.

In costume, for instance, it is interesting to observe how the best designers of women's dress, whatever be the fashion of the moment, start with a logical scheme for the construction of the garment, upon which it is either really or supposably built. Thus a triangular front and collar, of a different color, will perhaps be interpreted as a separate under-jacket, and will justify the use of the same material and color for the ostensible under-sleeve. When elaborate draperies of the skirts are worn, the same constructional principle is observed.

So, in architecture, a style is more broadly defined as a coherent system of construction, reasonably and suitably adorned. Specifically, it has been said that the points wherein one system of construction is to be distinguished from another, so as to constitute an architectural style, are two,—the method of roofing areas, and the method of bridging openings. Thus, not to enter into too great detail, the classical styles of antiquity are based upon the lintel, for covering both openings in walls and for roofing areas. In all probability the typical buildings of the Greeks were supposed to be roofed with stone, as well as stone-lintelled at doorways and intercolumniations.

Whatever view we may take of the unexhausted question of the hypæthral temple, there is no doubt that the colonnaded side-aisles, as well as the external colonnades, suggest, by their massive columns and narrow spans, the stone roofs of the Egyptians. And, although the central space was certainly often, indeed usually, roofed, yet the leading idea of all buildings of warm countries is the courtyard, not the roof; the open peristyle for coolness, not the enclosed hall and hearth for warmth.

Even private dwellings were grouped about a central court of some kind, and, although convenience made it necessary to cover the court of the temple, it probably remained—in theory, at least—an open court, while the narrow intervals of the surrounding colonnades permitted flat stone roofs, to match the stone architraves. The ceilings of the colonnades are known to have been of stone, and the timber roof above these is not more anomalous than the same anomaly in Gothic construction.

The next completely-developed system of construction, the mediæval Gothic, was based upon a development of stone vaulting for roofing areas, resulting in the familiar pointed arch, as constructively most available; the arches over openings in walls, also arched, in outline correspondingly pointed.

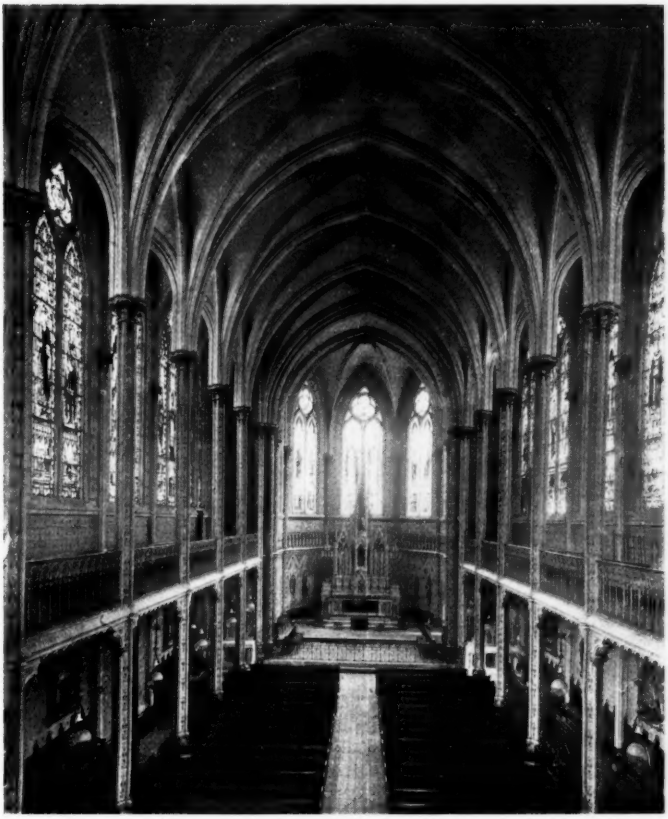
In all other styles arches and lintels have been used, no doubt, as the pointed and horseshoe arches in Moorish work, where arched construction reached a certain stage of very beautiful and logical elaboration; but the Greek and the flower of the Gothic styles have ever been regarded as the most complete working out of their respective principles of construction.

We are to seek, then, not for a new scheme of decoration,—that will come of itself in due course,—we are to look rather for the possibility of a new system of construction, and chiefly as applied to covering in spaces, and to spanning openings in walls.

For these purposes architecture has as yet advanced no new device beyond those known from immemorial ages,—the lintel and the arch. Even in such work as has involved the use of that really new material, iron, architecture has stuck to the old forms. So, too, for the most part, has engineering: yet, in addition, there have been used in engineering work two new principles, both exceedingly well adapted to iron as a material, and one of them, I think, architecturally available.

One of these is the suspension principle, the other the cantilever,—both tolerably familiar to everybody.

Of the suspension principle I shall not now speak, although it is not at all impossible that it might be used for covering vast areas. I can easily imagine an international exhibition hall of unheard-of magni-

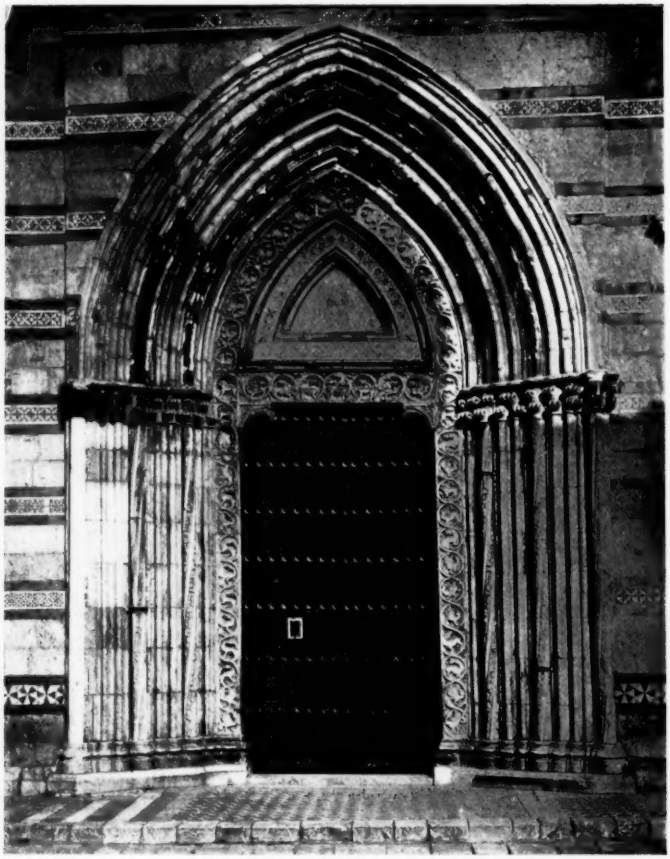


CHAPELLE DES FRÈRES AT RHEIMS.

A Typical Gothic Vault.

tude, perhaps a thousand feet in span, of which the roof might be suspended, as is a suspension-bridge. Still, except for very unusual occasions, the suspension principle is hardly practicable ; nor in any case does it seem to offer any corresponding facility in bridging openings in walls that we have postulated as one of the requirements of a construction that can aspire to be the basis of a style.

The cantilever principle, on the other hand, does, I think, fulfil both the requirements. It is capable of satisfactorily covering areas, and also of bridging openings, while, as distinct essentially from both



DOOR OF CATHEDRAL AT MESSINA.
A Typical Gothic Arched Opening.

the lintel and the arch, it is, I believe, sufficient to eventually give birth to a new and coherent use of harmonious ornament.

The principle of the cantilever, to put it paradoxically, is that you can double the strength of a beam by cutting it in two.

In Fig. 1, for instance, we see a beam, say, twenty feet long, capable of sustaining, say, ten thousand pounds. If, now, the beam be sawed in two, at A and B, the middle piece, being only half the length of the whole beam, will sustain twice the load,—in this case, twenty

thousand pounds. The end pieces also are each capable of sustaining ten thousand, each its share of the load of the middle piece. True, they could not for a moment stand, as they are shown in Fig. 1 ; they

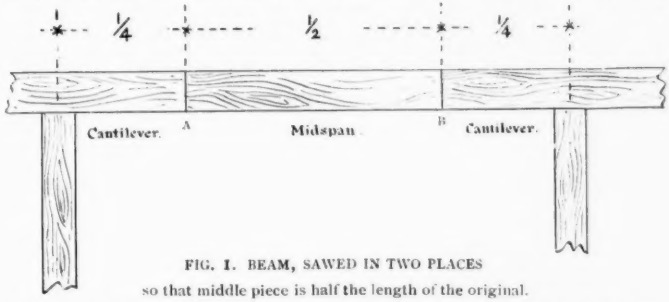


FIG. 1. BEAM, SAWED IN TWO PLACES
so that middle piece is half the length of the original.

must extend over the supporting post, and be held down at the outer extremity by another load, or some other device, as in Fig. 2, or they must be braced by diagonal bracket-pieces. The former arrangement

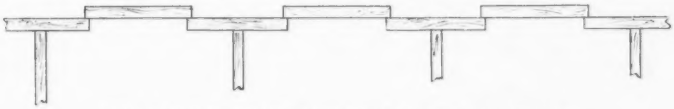


FIG. 2. SUCCESSION OF BEAMS SAWED INTO HALF LENGTHS.
The upper pieces shown a little longer, so as to rest upon the lower pieces which form the cantilevers.

approaches the condition of a continuous girder, and usually needs the addition of bracket-braces, not to add strength, but to provide for irregularity of loading.

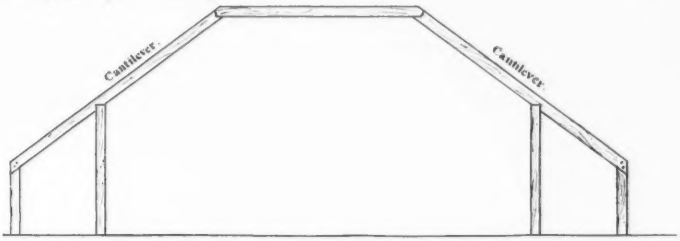


FIG. 3. DIAGRAM SHOWING THE PRINCIPLE OF CANTILEVER ROOF-TRUSS.
As long as the bearings are level, there is no horizontal thrust.

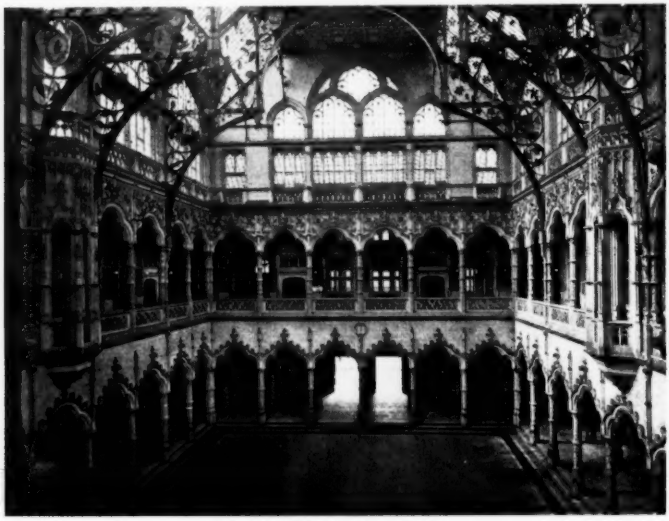
Now, this cantilever principle is very flexible, and may be adapted to many different situations, and to each in varying forms.

In the first place, we may arrange the abutment pieces on a slope, as in Fig. 3, and, as long as we hold the ends firmly down, we have a

support for an open roof, without tie-rod, and without thrust; surmounting at a leap the chief obstacle to the employment of iron roofs on a large scale, where appearance is of moment.

And, as in all true architecture, we have sacrificed nothing constructively for the sake of looks, but at one blow have improved both the construction and the appearance.

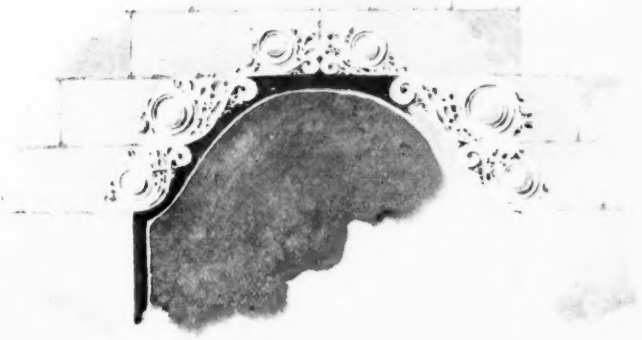
The only condition that attaches to this construction is that there shall be some part of the building, outside the principal span, where the outer ends of the cantilevers may project, and be suitably held down. For many buildings an outer aisle of this kind is natural and reasonable enough. Almost all theatres, music halls, churches, and



THE BOURSE AT ANTWERP.
Good Decoration of Iron Construction.

similar buildings for audiences require galleries for seating. Chautauqua assemblies and summer-school halls require adjacent class-rooms, which may conveniently flank the larger hall. Large exhibition buildings—for political conventions, shows of various kinds, athletic contests, fairs, or expositions—naturally adapt themselves to these interior aisles. Or, where interior aisles are unsuitable, exterior arcades, or flanking rows of subordinate rooms, may often be introduced, giving an opportunity for the use of cantilever construction.

Of course the simple diagrams hitherto shown are not the forms in which the cantilever is usually available. Some form of truss, both for



DESIGN FOR CARVED CANTILEVER WINDOW OR DOOR-HEAD.

the cantilevers and for the connecting piece, must be adopted. A simple trussed cantilever roof for timber construction is shown in Fig. 4. In this the cantilevers may be erected in separate pieces and connected by suitable longitudinal bracing; the trusses of the middle span may then be lifted in one piece, after framing on the ground. In fact, it is one of the great advantages of the cantilever system that it dispenses, to a great extent, with the scaffolding and false works that the ordinary truss must have.

In Fig. 5 is shown a suggestion for an iron cantilever roof suitable for a large hall with rooms on each side, either in one tier or in two. In the drawing the second tier of openings is shown as windows, but it

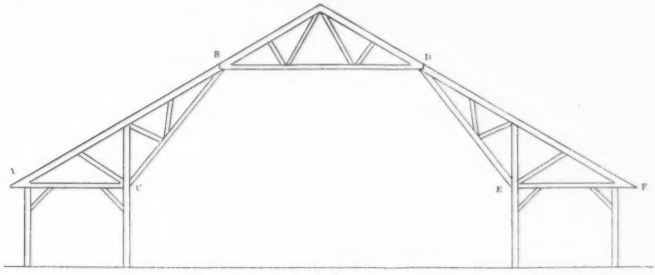


FIG. 4. SIMPLE WOODEN CANTILEVER TRUSS.
The framed triangles, ABC, DEF, are the cantilevers.

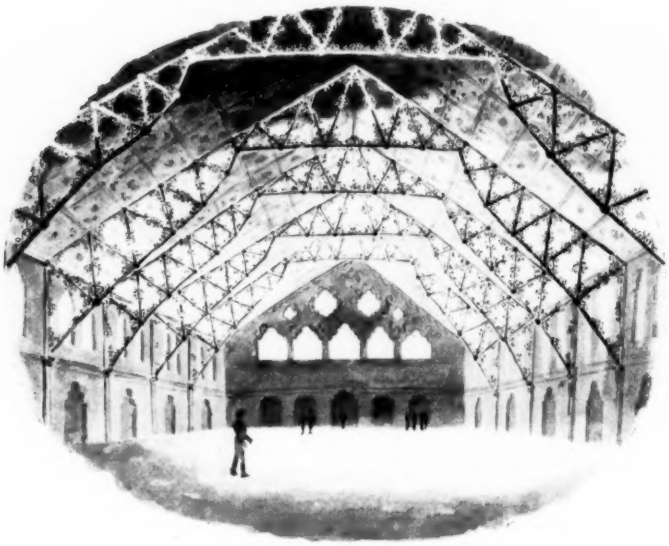


FIG. 5. DESIGN FOR LARGE HALL

with cantilever truss roof, and flanked by smaller rooms. Suitable for an armory, railroad station, etc.

might as well be used for a second story of rooms, and the large hall lighted from the ends and roof. The outer ends of the cantilevers of course are not seen ; they are supposed to be in the partitions between the flanking rooms.

Such a hall might be used for a railroad station, or for an armory ; while, instead of flanking rooms, either internal or external corridors or colonnades may be substituted, producing endless possibilities in adapting the principle.

One peculiarity of a cantilever roof is that there is no pressure on the outer line of supports, if we may call those supports that hold down, instead of holding up. These become really ties, and the foundation must be arranged to bear a pull-up rather than a push-down.

Besides its flexibility in covering wide spans, the cantilever principle has been used to some extent for ordinary floors.

There is a system of fireproof floors that is really a cantilever system. Being a patented device, it will probably not come into general use, but it shows the practicability of the cantilever principle for the most various situations.

One thing, it will be observed, I assume,—that iron is to be the

material of the future for floors and roofs. That an ordinary iron truss is about as ugly a thing as can be imagined perhaps all will admit. I am not sure, though, that this ugliness is a necessary quality of iron work. Certainly, where delicacy—at least comparative delicacy—of parts is an essential characteristic, and where geometrical figures govern the proportions, ugliness ought not to result; a spider-web is a type that is far from ugly; rather is it the very embodiment of the ideal, a swing for Ariel himself.

It is possible that the future may find methods of detailing truss-work that will display its natural esthetic advantages better than they are displayed by most of the iron work that is done.

In estimating the beauty of ironwork it must be remembered that anything like reasonable ornament for it is seldom attempted. It is not fair to abuse iron as esthetically wanting, as long as we use it only in its baldest and crudest shape. If we take a plain brick wall twelve inches thick and five feet high, we shall find it as deficient in beauty as any iron frame can be.

No more does a plain concrete dome display the glories of a Pantheon. Ribs, or panelling, or at least a color treatment of the smooth hollow, is needed to make it beautiful.

The proper adornment of iron truss-work is of the same nature as that used in iron work on a small scale,—delicate iron scrolls, attached to the main trunks, and saying in their own graceful way to all beholders that their material is strong and ductile, powerful to suspend as well as to sustain.

Something like this has been attempted in the truss shown in Fig. 5.

When iron comes to be regarded as a legitimate material for artistic treatment,—a position which it is slowly approaching, though it has not yet reached it,—new methods of construction perhaps will be discovered, lending themselves more naturally to architectural treatment. It is possible, for instance, that the principle of the tube may be susceptible of development to an extent now unsuspected. Why should not the cantilever trusses of the future, or indeed the various other trusses of the present, be constructed of tubes?

Both for ties and struts the tube is as available as the rod and the rolled shape. When used for ties, the additional diameter may remedy the appearance of excessive flimsiness; and, when used for struts, the shapeliness of the tube would happily replace the awkwardness of Z's, channels, and angles.

To form some notion of the advantage of the tube, both constructively and in appearance, imagine the difficulty there would be in building a bicycle of angle-irons instead of tubes, and the very unat-

tractive appearance of the result; whereas the bicycle built of tubes—a manifestly suitable material—is at least as beautiful as any other wheeled vehicle.

It is hardly worth while in an article meant to be merely a suggestive and interesting speculation to enter into any precise statements of the greater strength of tubes compared with other sections.

One point may be remarked, however,—that the tube is of especial value in such designs as require the members to be reciprocally available as either ties or struts. Architectural trusses most of all require this adaptability, as they are subjected more than others to irregular longitudinal strains, especially from wind-pressure. Further, it may be noted in reference to tube trusses, that the jointing naturally develops into a system, jointing now being notably unsystematic. With tubes a screw joint becomes the natural joint for all situations, with suitable rings, spheres, or such, at the connecting points.

Conceive, for a moment, a truss thus built, of tubes perhaps from three to six inches in diameter, with pronounced bosses at all the intersections, forming admirable motives for decoration, and consider whether it might not rescue iron work from its neglected position in architectural design.

Filled internally with some rust-preventing packing,—sawdust and asphaltum perhaps, or something of the sort,—such a truss could be easily protected on the outside, and made sufficiently enduring for its purpose,—as much so as the ancient oaken roofs that we admire.

Truss-building with such materials would become pipe-fitting on a large scale, and, with appropriate appliances, would permit the building of a truss on the spot, as a carpentry frame is now built, the tubes being shipped to the job in stock lengths, cut off, threaded, and screwed together.

Another use of filling may be found in adapting iron supports to proper architectural treatment. The ordinary rolled-iron column, with its rivetted ridges, is scarcely a beautiful object. But, if steel pipes of large diameter, say from ten to twenty inches, should become easily obtainable, their appearance would be pleasing, and their strength could be much increased by a solid filling of concrete, asphaltic or otherwise in composition. The strength of a compound column such as this is hardly calculable, but would have to be determined by experiment; it might be regarded either as a concrete column, restrained from bursting by a continuous skin of iron, or as a shell of iron braced throughout its height, prevented from collapsing by the solid filling.

These hints are thrown out merely to reconcile the mind as to the architectural possibilities of iron, and not with immediate reference to the cantilever as the basis of a future style.

As to this, we have spoken at length of the cantilever, whether of iron or of wood, as used for roofing areas; it remains to speak of the principle as adaptable to bridging openings.

We may assume that stone and brick will remain the customary materials for the enclosing walls, whatever be the material of the roofing.

Interpreted in stone, the cantilever becomes the bracket, or corbel, much used in the past, but never a preponderating motive of design.

It is, nevertheless, I think, well suited to become such a motive. Fragile as stone is when subjected to a cross-strain, this fragility has proved no bar to its use in the lintelled styles. When used as a bracket, or more properly as a cantilever,—for the simple projecting beam was first called a cantilever and exhibits the true cantilever principle,—stone is at least as appropriately employed as for a lintel, and the more so as, by diminishing the leverage of the cantilever, we in-

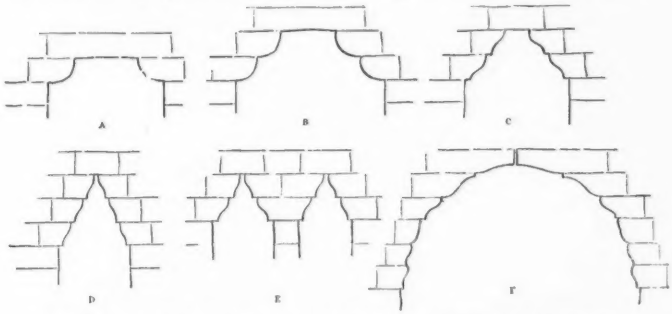


FIG. 6. VARIOUS FORMS OF CANTILEVERS AS USED TO SPACE OPENINGS.

definitely add to the serviceability of the stone. One point must be borne in mind,—that, although stone lintels often break, they seldom fall immediately. The compressive strength of the upper part at once comes into play when breakage has happened, and is usually enough to sustain the lintel,—at any rate, for a while. But, in the case of a cantilever of stone, the projecting end, if broken, drops at once. Consequently we cannot risk even half the projection for a stone cantilever of given depth that a mere calculation of its comparative strength would permit.

Laying aside all idea of decoration for the moment, consider the variety of forms this cantilever construction will permit in bridging openings, of which a few of the scores that are possible are shown in Fig. 6. In that figure A shows the simplest use of the stone cantilever, shortening the span and at the same time softening the angle of

the opening, which is the harshest point in lintelled design. B and C show a double cantilever on each side. The principle is as available for tall and narrow openings, as seen at D; while at E a coupled opening at once brings to mind the possibilities of the development of that desideratum in architecture, the bracket capital.

On a larger scale and for greater spans the same motive may be elaborated in various ways, as at F, which falls upon the outline of a full-centered arch. When arched openings on a curved plan are required, this is clearly the logical system of construction.

All of these, it must be remembered, are of the crudest and most off-hand description, the profiles being unstudied and only such as first occurred to the mind.

Even so, some of the arrangements are graceful enough as they stand, and all are evidently capable of graceful development with due study.

With much diffidence I advance a design for an enriched window-head on this principle—in Fig. 7. No one is better aware than I am of the defects in it, or more alive to the truth that a correct treatment of such a feature can be worked out only as a part of a whole. Nevertheless, I throw it out as part of a whole as yet existent only in my mind.

For brickwork the bracketed treatment is especially well suited, the ordinary corbelling, hitherto used timidly and in hidden places, being easily adapted to visible adornment. The stepped diagonal lines harmonize well with the corresponding lines upon which relief diaper and other ornament naturally works in brick, and the steps themselves, inevitably somewhat rough, suit well with the slightly-projecting courses in which the best handling of brick is done.

There is a noteworthy consideration, from a philosophical point of view, in this matter,—that the principles of classical and Gothic design are for the first time united. The genius of the Greek was to refine and adorn the solids, and let the openings take care of themselves; the column, not the intercolumniation, was his care. But with the medieval it was the form of the opening that ruled; the outline of the space enclosed by the arch, whether of aisle or window, rather than that of pier or column.

With the cantilever, both the outline of the opening and the profile of the cantilever itself present themselves as necessary considerations; either one done awkwardly detracts from the result.

THE USE OF ELECTRIC POWER IN SMALL UNITS.

By William Elmer, Jr.

ONE of the most promising fields for the electric motor is to be found in those places where it may be used in small units, particularly in mills and factories. The difficulties in the way, however, have, up to the present time, somewhat limited this use of motors. These difficulties are various, among them the conservatism of past practice being not the least. Power-buildings in cities, for instance, are almost universally laid out on the old and well-established lines of a Corliss engine and boiler plant located in the basement, transmitting power to the various floors by belting. On each floor long lines of shafting are carried throughout the length of the building, and all machines must be so arranged as to conform to this system. The details of light and the safety of operatives are sacrificed to the rigid requirements of a line of shafting. These requirements are particularly inconvenient and distasteful in buildings of the class just mentioned, on account of the diversity of the businesses and occupations carried on under one roof. One man may want his machinery arranged in a widely-different manner from that in which the machinery of his neighbor on the next floor is arranged; yet all have to submit to the provisions as they find them.

How much more advantageous to the customer would it be if he were allowed, for his own convenience, perfect freedom in the location of his machinery and appliances! This end could be attained by the use of small electric motors. If the customer's tools and machines were of such a character that they could best be operated in groups on a short section of countershaft, that would be the arrangement he would be likely to adopt. If they were of such a character and so conditioned by the exigencies of service that they required their own motor, they could be set up in the most convenient locations and be supplied from the power-wires in large or small quantities. The ease of control of these separate outfits, together with the independence of line-shaft speeds and directions of rotation, constitutes decided advantages to the users of small powers. In addition to this, it may be noted that any single industry might run over-time without the expense of keeping long lines of shafting in useless motion. Any tool or machine can be easily and quickly changed to a new location, and power supplied to it in the simplest manner.

So much for the consumer. How about the producers,—the owners of the building, for instance? As much can be stated on their behalf. If the matter comes down to dollars and cents, as in the end it does, it can easily be shown that they save money in the electrical system. If to the useful power produced is added the friction load of long lines of heavy shafting, the value of the coal consumed, plus the interest, depreciation, and other charges, will amount to more than the electrical transmission would cost, for with the latter there is no waste save the friction of the generators and the electrical transmission and transformation losses. Even with these combined, electrical transmission can always equal shaft transmission in efficiency, and, when the shafting is only partly loaded, the showing is much better for the electrical method. But, even if the actual cost of the latter system were greater than the other, it would be to the advantage of the owners to furnish power by this means. The building would be in greater demand by a better class of tenants, to the mutual benefit of all concerned.

Many of the power-buildings to be erected in the near future will be planned on the lines here sketched, and it is not too much to expect that some of those already employing shaft-and-belt transmission will be converted at an early date. Perhaps under more propitious circumstances this would have been done in many cases already, but the financial conditions of the last three years have absolutely precluded improvements not imperatively necessary. No sane man in these times is spending money for things not needed, and, so long as the power-transmissions already in use are doing their duty, it is idle to expect large investments to be made for new methods. But, with restored confidence and a liberation of capital, such changes will surely take place.

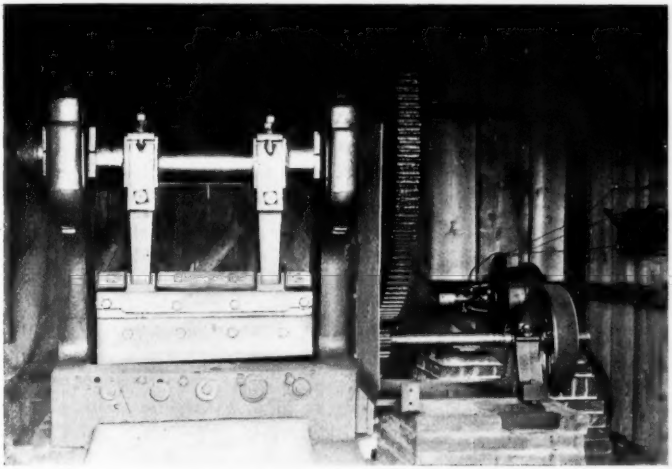
Another class of buildings in which we shall some day see a large employment of electric motors in small units is that constituted by the ordinary shops of industrial establishments. The machine shops and carpenter shops, as well as the various departments of many specialized industries, will be large employers of individual motors. It is not, of course, laid down as a law that each machine should have its own motor. This would, at present at any rate, be distinctly bad practice, necessitating, in some instances, the tying-up of large amounts of capital in numerous small motors, without compensating advantages. But the fact remains evident that in a great many cases the advantage lies decidedly on the side of the direct-connected individual motor. Taking the price of power and the cost of transmission as they stand to-day, the electric motor can compete on an even footing. And when to this fact are added the advantages of no belts to be relaced

and renewed, no shafting to be oiled and lined, no restrictions as to the location of machines, and an absolutely clear head room for both traveling and stationary cranes, it may well be asked why the individual motor is the exception and not the rule. Why do not shops all over the country enter their orders for dozens of one-, three-, and five-horse-power motors? If this is all so, why does not the careful manager, mindful of the best interests of his concern, hasten to replace his obsolete methods by more modern ones? The answer is: simply because he is a careful manager. As was said before, the reason can probably be found, in a large majority of instances, in the fact of the recent and lasting business depression. He cannot afford to swamp his concern by the immediate application of large amounts of capital. The problem which at present confronts us is not how much money we can make, but how little we can lose. Very few businesses have been making money lately, and to this fact alone can fairly be attributed the delay in changing to direct driving methods. The old and established shops, as a matter of course, in view of what has been shown, are not expected to change their methods of driving all at once, but it is encouraging, and one of the signs of the times, to find here and there a new plant being equipped with individual motors, or a group-driving system. And this method is not limited to one class of industries. From a machine shop to a cotton mill, through a considerable range of varied manufactures, this system can be seen to-day. It is liked, and it is spreading, and, along with the other improvements coincident with the revival of business, will be found the individual motor.

It may be interesting to note some instances occurring in the writer's practice in which the solutions of the problems presented indicate the process of evolution, inevitably pointing the way to the future state of the art. An average case, and one which perhaps will serve as well as any to illustrate the point, is the following: A large shear, used for cutting up scrap-wire in heavy sizes, was operated in a small building of its own, at a considerable distance from the boiler plant of the mill. Steam was taken by a long line of piping to the engine which ran the shear, this engine being built directly on the frame and coupled direct to the crank shaft. Somehow, early one Monday morning, the throttle valve of the engine was opened slightly, perhaps to drain the pipes of the condensed water. At any rate, when the steam came on, off the engine started, and, with no attendant near it, constantly accelerated speed, until it wrecked itself. It was found a mass of broken and twisted parts at seven o'clock. The question then arose as to whether to rebuild the engine or substitute an electric motor; the mill in question had its own electric-lighting and power

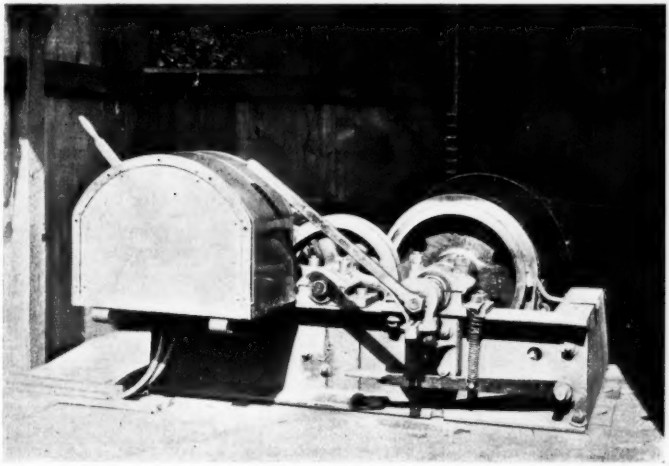
plant, together with an electric railway for the convenient handling of coal and material in process of manufacture; as the wires were near at hand and a suitable motor lay in the storeroom, the most obvious solution was the application of the latter. When to these advantages were also added the further ones that such accidents would be impossible in the future, and that the condensation of steam constantly going on in a long line of piping would be stopped, the choice was made at once in favor of the motor. The crank disc was taken off the shear shaft, and a large gear was keyed in its place. The motor, supported on a bracket bolted to the frame, had a pinion on its armature shaft arranged to mesh into this gear, and, after the proper connections were made with the service-wires, all was ready for the test. The motor was started slowly, the shear came up to speed easily, and everything worked smoothly until the first cut was made. As soon as the blade came down on the hard steel, the whole frame jarred, so that the carbon brushes jumped clear from the commutator, making a bad flash. All adjustments failed to correct the difficulty; building a pier under the motor did not help matters much, and the individual motor seemed to be a failure. The termination of the trouble was, of course, reached in providing the motor with a foundation of its own and belting to a short shaft carrying a pinion which engaged with the large gear. No jar was transmitted by the belt, and the motor now runs as smoothly as possible. This difficulty will have to be faced in the construction of direct-connected machine tools, which are subjected to shocks and jars, and should be met by making all the parts heavy and solid, and by providing the machine with a good foundation. Then there will be no more trouble in running a shear or press than in running a lathe.

Another case in which the substitution of electricity for steam was decided upon also involved peculiar difficulties of its own. This was a dock hoist used for unloading boats, and was operated by an ordinary semi-portable hoisting engine. After many breakdowns and repairs, it was finally decided to build an electric hoist. This work was done in the machine shops of the company, and a very compact and efficient machine was produced. Then came the question of control; the hoist would be subjected to all sorts of ill treatment, and would sometimes be run by the ordinary Hungarian yard-laborer, and by others who knew nothing of electricity and the handling of electric motors. It was therefore decided to arrange something which would effectually prevent ignorant and careless treatment of the motor and rheostat from resulting in harm to either. A form of construction as simple as possible was chosen, bearing a good deal of resemblance to the ordinary lever operating the clutch of the friction-drum; that was



ELECTRIC MOTOR OPERATING SHEAR.

simplicity itself, being merely a bar a couple of feet long operating in a vertical plane through an arc of about 60°. The controller was arranged with such a lever, thus necessitating a comparatively small num-

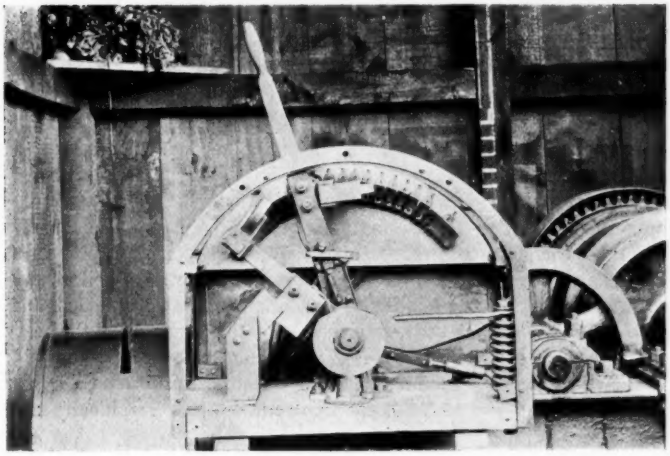


AN ELECTRIC HOIST.

ber of contacts, in order to get them in the space swept over by the contact-brush. This implied a considerable difference of potential between adjacent notches, and would probably have led to destructive arcing and burning up of the contacts very rapidly in stepping back a notch. The next step was to arrange a device to prevent this dropping-back. Another and shorter lever was pivoted to the same shaft as the main lever, and was arranged to sweep over a continuous solid segment throughout its path, except near the end, where it slid off the brass on to an insulating block of the same height and about three inches long. The idea was to release this lever as soon as a backward movement of the handle was made,* and have all the break made at once in a place where a renewable tip was all that would be necessary to take up wear.

A heavy spring supplied the motive power for this quick return lever, and a latching device was applied, which carried forward both levers together. As soon as the main lever was moved slightly backward, however, a roller sliding up an incline plane on a yoke forging drew the latch up with it and released the cut-off lever. This quickly flew back before the main lever could be moved far, and cut off all current from the segments, thus entirely preventing arcing on their edges. The only remaining thing to be done was to provide a small cylinder and piston to act as a dash pot, and insure a proper slowness in throwing over the main lever. It was also decided to make the resistance-coils of such material and size that the motor could run indefinitely on any notch without undue heating. They consisted of coils wound on asbestos-covered iron cylinders, provided with end plates sufficiently large to keep a cover of wire netting clear of contact. These separate boxes, several in number, are stowed away inside the frame of the hoist, where they are out of the way and are always kept cool by the free access of air through the netting. By this brief outline of the construction it will be seen what difficulties are avoided and what advantages secured. Any one who could run the engine hoist can run this without special instruction. He cannot hurt the motor by putting on the load too fast; he cannot hurt the resistance by standing on any one segment too long; and he cannot hurt the segments by coming back slowly or dropping back a notch or two. The principal difficulty in devising this mechanism was found in trying to provide a simple and reliable means of performing the unlatching of the quick-return lever. This was effected by constructing a yoke embracing the main lever, giving the latter a movement of about half an inch before

* This device was original with the writer, who was not aware of the experiments which were being conducted, probably simultaneously, by the Walker Co. The first intimation he had of other work being done in this line was the appearance of their advertisements in June, long after the completed controller had given eminent satisfaction.



CONTROLLER FOR ELECTRIC HOIST.

striking the yoke and carrying it along. A friction disc was provided to retard the motion of the yoke, and this holds the latter still on the return movement, while the roller runs up the incline and withdraws the latch, thus releasing the short lever. On the forward motion the latch is down, engages with the quick-return lever, and carries it along. The operation of this controller can be as well indicated by the description published by the Walker Company as if it had been written especially for it. "The mechanism of the breaking switch is so arranged that, with a movement of the controlling handle backward, the circuit is completely opened by means of this switch, leaving the [contacts] entirely dead. The circuit cannot be again closed until the controlling handle has been brought back to the 'off' position. After the circuit has been once opened by this slight backward movement of the handle, the controlling [lever] can be moved backward and forward into any position, without producing any effect, and it is absolutely necessary to go back to the 'off' position before the switch can be again closed. This feature of the controller makes it impossible to drop back from one notch to another in such a way as to put in or take out resistances in the circuit. This is a point that has always heretofore been carefully covered in the instructions to [operators], but at the same time it has been found that such instructions are often disregarded, it being much easier in many cases, if a decreased speed is wanted, to drop back one or two notches, as the case may be, instead of first cutting off the current completely. There is another point of

considerable advantage in the quickness with which the circuit can be opened." The similarity of aim in these two controllers is somewhat remarkable, and it is to be hoped that the diverse means taken to accomplish the same effect may prove equally appropriate.

One of the first questions that arises in the application of electric motors is that regarding the amount of power needed. How large a motor should be used? This question is directly answered by a dynamometer, in which a nest of bevel gears transmits power from the driven pulley to the driving one, and at the same time applies torque to the balance arm. This is steadied by a dash pot, and weights are added until the beam remains horizontal. A bell on the machine strikes at every hundredth revolution, so that all the operator has to do is to note the number of seconds between strokes of the bell, and count up the weights; dividing the latter by the former, and this quotient by 550, gives the horse power. In order to shorten even this simple operation, a table has been prepared, showing graphically the

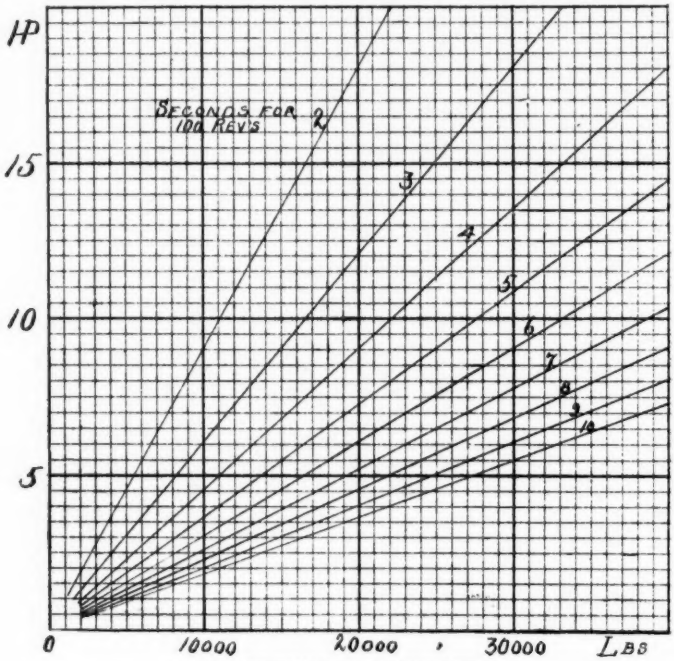
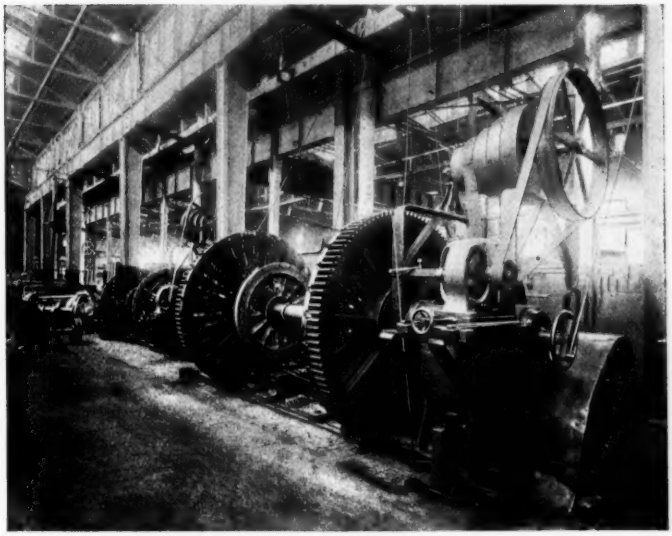


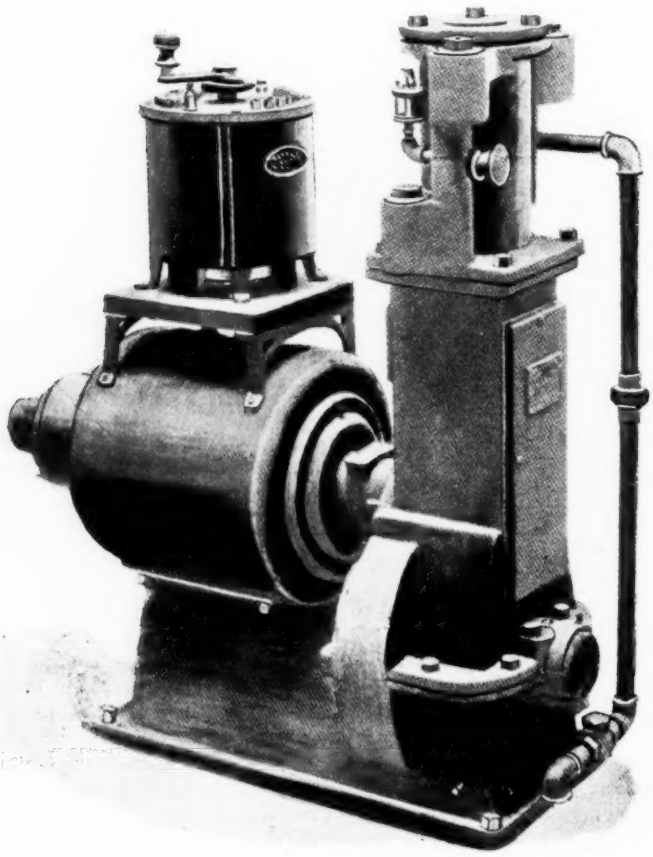
TABLE OF DYNAMOMETER HORSE POWERS.



LARGE LATHE WITH DIRECT-CONNECTED MOTOR.

power absorbed at any number of seconds for 100 revolutions, and with any weights. Suppose 7 seconds elapse between strokes of the bell, and the weights count up to 16,500 pounds; the 7-second diagonal is followed out until the intersection of the 16,500-pound ordinate is reached, when, by following back the horizontal line to the vertical axis, the horse power is read direct. This dynamometer can be placed between the line shaft and any tool or machine with the greatest ease. The belt is taken off and hung up, and a short piece of experimental belting run from the driving pulley to the upper pulley of the dynamometer. The lower pulley is then connected to the driven machine by another belt, and the direction of rotation, as well as the speed, is preserved. Fast and loose pulleys enable the whole operation to be completed in a very short time. The horse power being determined, the size of the motor is fixed, and it remains only to show by what means these motors should be supplied with power.

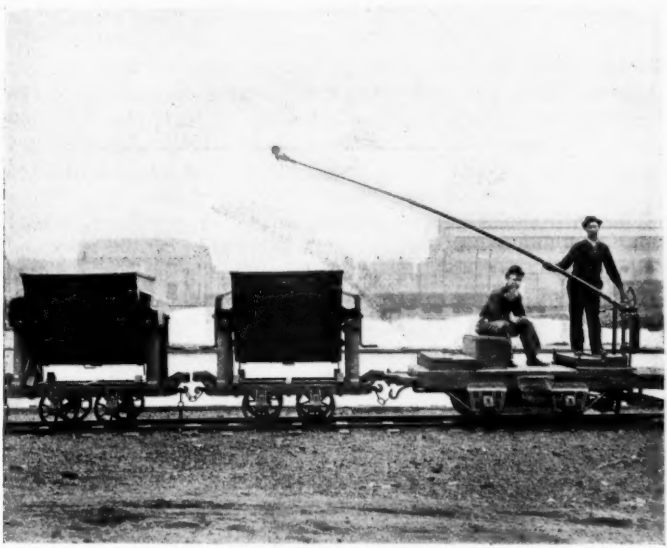
Of the several systems in use at the present time, the ordinary direct-current shunt-wound motor has by far the widest application. Without making any comparisons, which are invidious, an ideal scheme is here sketched out, which could be applied to a large number of mills and factories as at present arranged. In the first place,



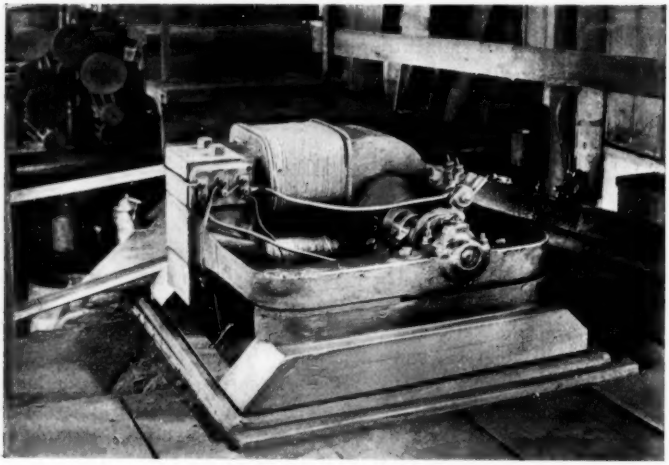
A DIRECT-CONNECTED AIR-COMPRESSOR.

nearly all modern manufacturing establishments are equipped with their own electric-light plants. These are sometimes supplemented with an electric-power plant, but it is safe to say that in the future these conditions will be reversed, and the electric-light plant will supplement the power plant. Better still, they will be combined in one, and the dynamos which serve as power-generators in the day-time will also furnish light during the dark afternoons and mornings,

as well as provide lights constantly in the dark corners and out-of-the-way locations. An eminently practical system of distribution appears to be two-phase alternating currents at a potential of 220 volts. This pressure is perfectly capable of easy control and insulation, and, at a very small outlay for copper, it is well adapted to extended distribution throughout large establishments, even those covering considerable ground. The question of incandescent lighting at great distances is solved by the use of 220-volt lamps, which are now on the market, and which have been proved by extended experience to be all that is claimed for them. These lamps can be wired directly across either pair of mains of the two-phase circuits, and, in fact, the ordinary mill wiring can be utilized, merely changing the lamps to 220 volts. The old 110-volt lamps can be used up by arranging one floor of a mill on the three-wire system, putting fifty or sixty lamps on each side; then the burning out of a few at a time will not materially affect the rest, and this arrangement can be continued until the supply of old lamps is exhausted. This distribution also solves the problem of arc lighting, as the wires, which run everywhere, can easily be tapped at suitable points, and groups of arc lamps, four in series, can be placed wherever wanted. If desirable, small transformers may be



AN ELECTRIC RAILWAY FOR HANDLING COAL.



AN OLD-TIME MOTOR, RUN SEVEN YEARS WITHOUT REPAIRS.

inserted, and single lamps supplied with the proper voltage for maximum economy.

And now for the motors. The pleasantest part has been left until the last; who can contemplate the modern induction motor without pleasure? No commutator, no brushes, no armatures grounding, just a simple cylinder of metal revolving on its axis. It can be placed on wall, floor, or ceiling, and left to itself indefinitely. If the motors are used to operate short sections of shafting, their switches can be left in, and they will start up in the morning with the main generators. If they are for intermittent work in small units, a single switch suffices to bring them into action. For variable speed they can be so wound that two widely-different speeds can be secured by a change in the connections of the stationary primary windings, each arrangement giving an efficiency of seventy-five or eighty per cent. in the small sizes; thus at one time the speed may be four hundred, and at another eight hundred, revolutions per minute. These motors could be built directly into the head-stock of a lathe, for instance, and a simple controller provided which would give four changes of speed of the armature, two by introducing resistance to a small extent, and two without any resistance. Either arrangement would be at an efficiency sufficiently high for all practical purposes, and, when taken in connection with the advantages to be gained by this system of distribution, would easily give the preference to electric power in small units.

THE IMPORTANCE AND ECONOMY OF PAVEMENT MAINTENANCE.

By S. Whinery.

THERE seems to prevail among urban residents and taxpayers an impression that a street pavement, if properly constructed, should require no care or attention whatever for a period of years; that, once completed, it may be dismissed from the mind of the public and the city authorities, and allowed to take care of itself. Should the hapless pavement fall short of this expectation, they are filled with indignation, and protest, rushing to the conclusion that some one has blundered or betrayed his trust.

It is difficult to account for this general opinion that pavements should be well-nigh indestructible, or, like the famous "one-horse shay," should maintain their full integrity until a ripe old age, and then fail altogether in one brief catastrophe. Certainly there is nothing in our experience to justify a belief in the absolute permanency of street pavements.

The man who builds a house with the greatest care and without regard to expense in the selection of materials is not surprised, however much he may be pained, to find that unforeseen imperfections in materials or workmanship appear sooner or later, after the structure is completed, requiring attention and repair. The engineer who builds a railroad or a canal knows very well that the work of maintenance and repair must frequently be commenced on some parts of the work before other parts are completed, and that thereafter he must expect a constant struggle with the elements, the wear of use, and the waste of accidents. Even the bridge-builder, in whose marvelous work we might justly expect a near approach to the perfection of the poet's "one horse shay," finds that rods must be readjusted, nuts tightened, and painting frequently renewed; and he is fortunate if no more serious defects require his early attention.

Street pavements afford no exception to the rule that all human structures decay and are impaired by use, and therefore require intelligent attention and timely repairs to maintain them in a condition of efficient service.

No one in these times doubts the great value to the citizen of good street pavements. They contribute more perhaps than any other city improvement to the comfort and convenience of the public. They promote business, and add to the material prosperity of the com-

munity. They enhance the value of property; they conduce to good health by making cleanliness and correct sanitation possible. They make an appropriate framing for the beautiful homes, surrounded by flowers and lawns, for which our American cities are noted. In short, they are both a necessity and a luxury of modern city life.

It is not surprising, therefore, that we find the subject of street pavements occupying much of the attention of both citizen and city official. No municipal problem is being more closely studied than that of how to provide our city streets with the best pavements at a reasonable cost. Able engineers are devoting themselves to this problem with the zeal its importance demands. They are studying the merits and demerits of the several kinds of pavement; they are preparing specifications for this work with the care and attention to detail that characterize the best modern practice among civil engineers in other lines of professional work. They are subjecting all the materials used to rigid inspection, in order to exclude everything that is defective, and placing eagle-eyed inspectors on the street to see that every part of the work is done in the best manner. The result is, as might be anticipated, that we are building in this country street pavements that do not suffer by comparison with the best in any country, creditable alike to the public that pays for them and to the city officials to whose supervision their excellence is due.

If the same intelligent and vigilant care were exercised in maintaining these pavements as in constructing them, their life and usefulness would be greatly prolonged, large sums of money would be saved to the tax-payers, and our paved streets would not become, as in too many cases they are, as discreditable to the community as they were creditable when first completed. Dirt and refuse of every kind are allowed to accumulate on their surfaces. The ruthless plumber, the gas-fitter, and the sewer-tapper are allowed to cut into or undermine them at will. When these have accomplished their purpose, they generally throw back the material removed without regard to the condition in which the pavement is left. Unlawful loads are hauled over them, breaking the surface or making ruts and depressions. The children build bonfires on them. In short, a street pavement seems to have no rights that the public is bound to respect.

It is not surprising that under such treatment the best of pavements come to need extensive repairs. The public and our city officials seem not to have learned the important lesson that, however well street pavements may be built, and however satisfactory they may be when first opened to use, their usefulness and beauty can be maintained and prolonged only by giving them the care that every other engineering structure must admittedly receive.

Even when the greatest care and vigilance are exercised by all parties concerned in their construction, unforeseen defects are almost sure to appear in time, either in the pavement itself, or in the various constructions under, or connected with, the pavement proper. Below the pavement is usually a net-work of pipes for various purposes, as well as large and deep-laid sewers. These are frequently not completed long enough before the pavement is placed over the trenches made for them to allow natural settlement of the material with which these trenches are filled, and little or no care is taken to properly compact the filling as it is replaced. It is not unusual to find that, by subsequent settlement of this filling, the pavement structure is left unsupported, and performs the services of a bridge as well as a pavement. As might be expected, the pavement is generally insufficient for this double service, and fails under some unusually heavy load that may be hauled over it. But, aside from such extraneous causes of failure, pavements are subjected to the destructive action of the elements, the casualties of use, and the abrasion of travel. No perfect and indestructible pavement has yet been discovered, nor will there be, for some of the qualities necessary to make a perfect pavement are antagonistic,—cannot exist together. Thus one of the essential qualities of a good pavement is that it must afford a good foothold for man and beast. Another is that it must be durable. To afford good foothold, there must be friction between the pavement and the feet of men and horses. There can be no friction without abrasion, and abrasion means destruction sooner or later.

The wear or disintegration and failure of pavements, and the consequent necessity for repairs, are due principally to two causes.

(1) If the material of which the pavement is constructed is subject to natural decay, it will in time be destroyed by this cause alone, regardless of the amount of travel to which it may be subjected.

(2) Whatever may be the natural durability of the materials of which the pavement is made, the action of the travel over it will in time wear it out. Its life will be measured by the character and quantity of the travel and the ability of the material to withstand that travel.

The frequency and extent to which pavements require repair differ with the materials used in their construction and the use to which they are subjected. Some pavements, among which may be named those properly built of good granite blocks, will require little repair, even under very heavy travel, for several years. On the other hand, a macadam pavement, however well it may have been constructed, will require constant care and attention, and more or less repair, from the time it is opened to travel. Brick pavement of the best character

should need little or no repair for a time after its completion, dependent on the quality of the brick used and the amount of travel it carries. Good asphalt pavement, the material of which is an artificial composition requiring great skill and experience to properly prepare and lay, is quite likely soon to develop weak spots requiring attention, but these should be neither great in extent or expensive to remedy.

The value of any pavement and the cost of maintaining it cannot be correctly judged from the fact that repairs become necessary at a comparatively early period. In the broad sense of the word, maintenance, as applied to pavements, covers:

(1) The cost of keeping the pavement in good repair from the time it is completed until it is so far worn out as to require renewal.

(2) The cost of renewal.

(3) The interest on the sums expended for repairs from the time those expenses are incurred until the renewal of the pavement. The sum of these three items divided by the life in years of the pavement will give the true annual cost of maintenance, and is the standard by which the relative economy of maintenance of the various kinds of pavements may be correctly judged.

It is not the purpose of this paper to consider the economic value of the several kinds of street pavement from this standpoint, but it may be observed that we have as yet few complete and reliable data for the solution of the problem, especially in America, and are left to depend upon estimates more or less speculative. We have, however, enough data to warrant the conclusion that macadam pavements, where subjected to considerable travel, are the most expensive of all pavements to maintain; that granite pavements, while requiring little repairs during the earlier years of their life, cost a relatively large sum for renewal, and cannot therefore be considered economical; that wooden-block pavements, as laid in this country, while short-lived, can be renewed cheaply, and are, therefore, if judged by this standard alone, economical; and that, while asphalt pavements may require slight repairs early in their life, the cost of maintenance for a long period of years will be very moderate, which is due partly to the facts that the pavement has a permanent concrete foundation, and that the asphalt surface can be renewed at a comparatively small cost. Our experience with brick pavements is yet too limited, and the quality of the brick used too variable, to enable us to form a fair estimate of the cost of maintaining them.

It ought to require no argument to establish the proposition that the same reasons that make it desirable to construct a good pavement apply as well to the keeping of it in proper repair. If it is necessary

to pave a street for economic reasons, it is equally necessary that the pavement shall be maintained in such condition as to accomplish its purpose. If a pavement is desirable for sanitary reasons, it is equally desirable that, after it is secured, it shall be kept in such condition as will best attain that end. If a street is paved for the reason that it will promote the comfort of people using it or living along it, and that it will add to the beauty and desirability of property adjoining it, certainly these ends will not be accomplished unless it is kept clean and in good repair. In short, if the pavement is considered of sufficient value to justify the expenditure of the large sum necessary for its construction, it should be of sufficient importance to be maintained in as nearly as possible its original good condition.

It is a downright waste of public funds to build good and beautiful streets, and then allow them to be ruined for the want of proper attention.

A famous saying has been so paraphrased as to read: "The price of good roads is eternal vigilance." This is forcible, but hardly accurate, the fact being that only as much vigilance and business sagacity are necessary as the good business man applies to his private business, as the efficient railroad manager applies to the care of his track, his structures, and his rolling-stock, as the prudent manufacturer applies to his machinery, or as the wise landlord applies to his buildings.

It is not possible here to go into details regarding the methods of repair. These will obviously differ somewhat with the different kinds of pavement to be dealt with, and some general observations only will be attempted.

It may first be noted that, as in medicine, "an ounce of prevention is worth a pound of cure." If pavements are properly cared for and protected, the amount of repair-work will be greatly reduced. They should be properly cleaned. While a blanket of street dirt may not be very injurious to some kinds of pavement, it will certainly greatly impair the life and usefulness of others. This is particularly true of wooden and asphalt pavements. There are the strongest reasons for keeping pavements clean, regardless of the fact that cleanliness is an important factor in maintaining them, but it should not be overlooked that the life of a pavement is prolonged, and the cost of its maintenance reduced, by keeping it clean. Pavements should not be sprinkled more than is absolutely necessary to prevent the discomfort and injury to property of flying street-dust. Proper cleaning will reduce the necessity of sprinkling to a minimum. The excessive use of water is a positive nuisance on paved streets. It reduces the dirt to a mantle of mud and slush that is more objectionable to those using the street, particularly to pedestrians, than dust. It makes thorough

cleaning impossible. These should be sufficient reasons for properly regulating the quantity of water used for necessary sprinkling. When it is added that it hastens decay, increases the effect of abrasion and wear, and thereby abridges the life and usefulness of the pavement, there is seen to be abundant reason for regulating this pernicious evil. Those who doubt its destructive effect should visit a stone-sawing establishment, where they will learn that the saws used for cutting the stone would have little or no effect, were it not for the constant stream of water supplied between the saw and the stone.

Street pavements should have the usual police protection accorded to other public works. The hauling of unusual and destructive loads over them, the building of bonfires on them, the spilling on them of oils and chemicals, and the careless or accidental placing or dropping on them of gravel, broken stone or brick, and refuse of all kinds should be prohibited under penalties. While it is impossible to avoid cutting into pavements to lay or repair pipes and other underground structures, this should be allowed only under stringent and well-defined regulations. The necessity for regulating this evil is so evident that one would think that every city would adopt and enforce the necessary legislation to control work of this character; but not so. Only a small number of American cities have taken the subject in hand properly. No official, corporation, or private individual should be permitted to make openings in any pavement except under stringent regulations providing for prompt restoration of the pavement to its original condition.

If all these and other like requirements were complied with, the necessity and cost of pavement repairs would be very greatly reduced.

The one general and important rule to follow with regard to necessary repairs is to make them promptly. If this rule be strictly followed, it will be found that the cost of maintenance will be reduced to a small fraction of what it would be were the repairs to be delayed until the slight defect had become a yawning gulf in the pavement. The saying, "a stitch in time saves nine," is nowhere more true than when applied to pavement maintenance.

The passage of an extremely heavy load may cause a slight depression in a pavement in some weak spot. The wheels of following vehicles drop into this depression, subjecting it to a blow where before only a steady pressure was exerted. This will deepen and extend the depression, and, as the force of the blows increases more rapidly than the depth of the depression, that spot of the pavement will soon be destroyed; and, as the adjoining pavement is deprived of lateral support, the depression not only deepens, but extends in every direction, until it becomes an unsightly and dangerous hole in the street which

it will cost dollars to repair, though at the beginning a few cents would have been sufficient. It is no exaggeration to say that, in every city having a considerable area of paved streets, many thousands of dollars could be saved annually by adopting and adhering to the policy of prompt repairs.

In most American cities the work of street-repairing is done directly by the municipality, under the direction usually of the superintendent of streets, who employs the labor, purchases the supplies, and superintends the work. In a few cities the plan has been tried of having this work done by contract, bids being advertised for and the work awarded to the lowest responsible bidder. It is still an open question which of these two systems is most efficient and economical. Against the contract system it may be said that it is difficult, if not impossible, to determine in advance the character or extent of the work required, and therefore it is impossible for contractors to submit intelligent bids; and that, under such conditions, the better and more responsible contractors are likely to bid very high in order to be safe, and the irresponsible contractors are likely to understimate the cost, or purposely bid too low, hoping, after obtaining the contract, to slight the work, in order to come out whole.

It may be further urged that a contractor for this class of city work, through political or other influence, not only might be able to obtain contracts by improper means, but, having obtained them, would use his influence to escape carrying out their terms fully and faithfully, so that the streets and pavements would be neglected and allowed to get into even worse condition than they usually are in under the direct management of the municipality.

On the other hand, it may be said that it has been the almost universal experience that cities can have their public work executed, not only more efficiently, but more economically, under the contract system. It is but natural that a contractor having a personal interest in the results of his work will look after its management more carefully than a paid official, whose salary is often not so much dependent on the efficiency of his work as upon his political influence. It is a well-known fact, the reasons for which we need not stop to examine here, that labor employed by municipalities nearly always costs more and is less efficient than that employed by private persons or contractors, and a contractor can therefore execute work at a less cost than can the municipality. Contractors in this department of public work are not more likely to resort to political influence to secure improper ends than in other departments where the contract system has been found advantageous, and this objection has, therefore, no greater weight against street-maintenance contracts than against contracts for other

municipal improvements. It is, or should be, easier for city officials to compel a contractor to comply strictly with a written contract than to secure equally good service from subordinates or fellow-officials. If it were the practice to contract for the maintenance of paved streets, contractors would soon appear who would make this kind of work a specialty and thus acquire sufficient experience and knowledge to estimate closely the cost of maintaining any street, and to bid intelligently. If the mischievous laws prevailing in many States, which compel the award of contracts to the lowest bidder who can furnish an acceptable bond, regardless of other qualifications, were annulled, and the responsibility of awarding contracts thrown directly on the municipal officers, there is little doubt that contracts could be placed with responsible and honest contractors, who would engage to perform the service at reasonable prices, and would live up to the letter and spirit of their contracts. Under such conditions it is certain that the work could and would be more thoroughly and efficiently done than by the municipality, and it is equally certain that the result would be a great saving in the cost to the city of street repair and maintenance. The system might be further extended, and pavements might be constructed under contracts covering the maintenance of the pavements for a long period of years. This is already done in a number of cities to a limited extent, and the results have been most satisfactory.

It is not improbable that the apparently excessive cost of the maintenance of roads and paved streets abroad is, to some extent, due to the fact that the work is done directly under municipal or governmental supervision, and not under the contract system. American cities would doubtless rebel against the expenditure of so much money upon our pavements as is considered necessary in European cities. We can, however, learn many valuable lessons from European practice in road and pavement maintenance, and we should study especially the complete and systematic organization of this department of municipal work in France, England, and Germany, where it receives the attention its importance demands. We should aim to secure the efficiency of their systems at the least possible cost. The solution of this problem is worthy of the best efforts of our ablest municipal engineers.

CONDITIONS GOVERNING THE CHOICE OF FUEL.

By H. M. Chance.

AS the selection of boilers, and the design, arrangement, and location of a steaming plant may be materially influenced by the character of the fuel, it is advisable that this should be determined in advance of the construction of the plant. When, from any cause, this cannot be done, the characteristics of the available fuel may be investigated to determine whether the choice will not be confined to a few varieties, the peculiarities of which may receive consideration in selecting boilers, in maturing the design, and in deciding upon the location of the plant.

Except in certain localities where natural gas or oil (crude petroleum) is available, and other districts in which cord-wood is still abundant and much cheaper than coal, the only fuel to be considered is coal (or coke), and the problem will be to determine which of the various available coals will give the greatest evaporation at the least cost.

Gas-producers do not appear to have yet reached a degree of efficiency and cheapness warranting the serious consideration of gas firing for steam making on a large scale. In establishments requiring gas-fired furnaces for other purposes, it may be good policy to operate the boiler plant with producer gas, and at present the use of producer gas is probably rightly limited to these exceptional cases. The steaming plants at blast furnaces and at by-product coke ovens naturally belong to this limited class, including all those cases in which the heat of waste gases, or of combustible gases from metallurgical operations, is so utilized. When such waste gases are available, economy obviously indicates their utilization in this way, and, where insufficient, they may be reinforced by producer gas (if available) or by coal. Recent improvements in the construction and operation of gas-producers rather promise a wider use of gas as a prime motor in gas engines than as fuel for steam-making.

In the gas and oil districts, and the cities to which either or both are piped, the fuel question is not always free from difficulties. Attention must be given to the probable future cost of both or either as compared with coal, and to the element of permanency or probable duration of the supply. At some plants located in these districts it has been found necessary or advisable to make frequent fuel changes ;

and instances might be quoted of plants originally designed to burn coal which have been changed to fire with natural gas, subsequently altered to burn crude petroleum, and finally changed back to coal.

No gas or oil district yet discovered in this country has had more than a very limited life; they all become practically exhausted in a few years. It is now generally admitted that the gas or oil is held under pressure in the interstices of porous sand rocks or conglomerates (or in porous or cavernous limestone), much as a sponge holds water, and that, when these are emptied, the field is exhausted. Hence, if gas or oil be available at prices relatively cheaper than coal, prudence requires that the plant be so designed and arranged that it may be quickly and cheaply changed to burn coal.

The advantages of gas and oil firing are self-evident, and the economies effected incidentally in many ways will often make gas or oil cheaper than coal, even when their prices, as compared on a thermal basis, are much higher than coal.

The thermal or fuel value of oil may be taken, approximately, as about twice that of a fair grade of coal, weight for weight. The fuel value of natural gas, while varying widely in different districts, is distinctly higher than oil, or, say, 2¼ times the value of coal, pound for pound. For approximate estimates the relative thermal values of average coal, oil, and gas may be thus expressed:

1 ton of coal = 3 bbls.* oil = 20,000 cu. ft. natural gas.

The cleanliness of an oil- or gas-fired plant—absence of dirt, smoke, and ashes—is a cardinal merit, while the increased life of the plant, reduced cost of operation, and ability to quickly raise steam, maintain constant pressure, and instantly force the plant to its greatest capacity, are features which commend these fuels. On the other hand, it is necessary to consider the fire risk incurred by the storage of crude petroleum in quantity, and the possibility of a more or less prolonged shut-down caused by any accident to the gas-well or pipe-line. The fire risk is practically eliminated by storing the oil at a distance from the works, and the risk of interrupted gas-supply will be small, if the pipe-line is fed from several wells and is properly protected.

Coal is steadily invading the timbered regions of the south and west, and in the majority of the larger towns and cities has already displaced cord-wood as a steam fuel at large plants.

One ton of coal is usually regarded as equivalent to from two to three cords of light wood, and to about one and a half cords of hard wood.

Only where wood is considerably cheaper than coal can there be

* One bbl. oil = 42 gallons.

any question as between these two fuels. The cost of cord-wood is steadily increasing, whereas the price of coal is as steadily falling, and we cannot doubt that this tendency will continue, and that in every locality the relative cost of wood as compared with coal will increase. Hence, only the most pronounced difference in favor of wood can justify its selection, and, even where a sufficient difference now exists to warrant the use of wood in preference to coal, the plant should, if possible, be so arranged and located as to render a future change to coal inexpensive.

In a vast majority of cases in which the engineer may be required to advise as to fuel, the only question will be which of several kinds or grades of coal can be most economically used for steam-producing. In the west the problem may often be complicated by the great variety of coals available, ranging from anthracite, through all the grades of bituminous coal, to the poorer grades of lignite. Under such conditions the problem is not easily solved.

At such points as Kansas City, Omaha, El Paso, Denver, Salt Lake City, Helena, or similarly-located places the market contains a puzzling variety of fuels. Lignites, some good and some very poor, from Wyoming, Dakota, and Montana; bituminous coals (coking) from Montana, Wyoming, Colorado, Kansas, Missouri, Iowa, and the Indian Territory, some of excellent quality, others of very low grade; semi-bituminous coal from New Mexico and Arkansas; and semi-anthracite from Arkansas and Colorado,—are some of the varieties from which a choice must be made. The difficulty of selection is increased because many of these coals have not been in the market long enough to find their proper place and value in relation to those with which they are in competition, and the prices at which they are sold often bear no relation to their thermal values. Under such conditions a high-priced fuel is usually one costing more to mine, or having to be transported a greater distance, than others sold at a lower price. Such a coal may be a high- or low-grade fuel; this can be determined only by close investigation. It may be assumed in advance that such a fuel must have some special merit to commend it to purchasers; else it would find no sale at the higher price. Inquiry may develop the fact that it is cleaner and brighter-looking, or more carefully prepared, or contains less fine slack, or stands exposure to the weather, or is less smoky or "sooty," or "holds fire" over night better, or has no unpleasant odor, or makes fewer clinkers, or is well advertised and pushed by energetic management. These and many other reasons may be discovered to explain why a certain coal is more popular and commands a higher price than its competitors, especially for domestic use and small industrial works, wholly irrespective, however, of the merits

or value of the coal as a fuel,—that is, of its merits as a producer of heat.

While some of the peculiarities commending a coal for domestic use are also advantageous in a steaming fuel, the value of any coal, ultimately, is measured by its capacity for producing heat. How many pounds of water will it evaporate per pound of coal, as compared with its competitors? This must always be the final measure of value, and will generally determine the choice. It is often an extremely difficult matter to decide a question of this kind, when the available coals differ widely in physical characteristics and chemical composition.

Nearly all of the large railroad systems in the west have been struggling with this problem, and, while some have solved it satisfactorily, others are yet uncertain whether their locomotive fuels are the best and cheapest available or not. In the case of these railroads the data from which conclusions have generally been drawn are compiled from the results of trial runs, or from trials extending over a considerable period. The value of the data secured in this way may be open to the objection that the conditions under which any two such tests are made are never identical, and also because the results attained are affected by the relative skill of the different firemen and engineers, and may, unconsciously, be more or less affected by prejudice for or against any particular coal. When the great railway systems, with their abundant facilities for testing, find difficulty in selecting the fuel best adapted to their use, how can one expect to make wise choice with none of these facilities at hand? It may be sufficient to answer frankly that, under such conditions, it is often quite impossible to determine in advance of the construction of a steam plant what particular coal will give the best results at the lowest cost. The best that can be will be to narrow the field down to two or three coals which appear to give the greatest fuel values at their current market prices. One method by which such an examination may be conducted has already been outlined by the writer in the April number of THE ENGINEERING MAGAZINE, under the title, "The Relative Value of Different Coals," and need not be repeated here. The calorimeter methods and results will be discussed in the closing paragraphs of the present article. Having by the method of comparison therein described selected two or three coals which give greatest promise of satisfaction, the boiler plant may be designed with a view to the use of any one of these coals, and the final selection can then be based upon the results of actual steaming trials made with each coal under similar conditions.

In the eastern and southern States the varieties of coal from which a selection must be made are far less numerous, being confined to

bituminous and anthracite coals, and the range in quality is also more restricted, the poorest grades of coal having long since been driven out of the market by the better grades; there is also less difference in the market price. While the problem is simplified by the practical absence of very poor coal, and by greater uniformity in prices, it is rendered tedious and troublesome by the large number of grades from which a selection must be made, the smaller differences in fuel value requiring more careful and accurate work.

Within a certain limited distance from the anthracite coal fields, anthracite is generally the preferred fuel. It has already been shown why anthracite coal with its theoretically small thermal value is, practically, a steam fuel of no mean value.*

If anthracite coal be preferred, and the proprietors of the proposed plant desire to use it, the choice is then restricted to the selection of the particular kind and grade of coal. The considerations advanced in the article referred to above may be applied to determine the quality and value of any of the available coals, and the main issue will probably be to determine what size of coal shall be used,—Pea or Buckwheat. If the plant be provided with sufficient grate-area to burn the smaller coal without forcing the fires, Buckwheat coal will generally prove more economical than the larger size; provided always, that a good quality, reasonably free from slate and "bony" coal, be secured. The advancing price of Buckwheat coal and the poor quality of much of it shipped to market in recent years have caused some large consumers to abandon it for Pea coal or for bituminous coal. This seems to be a retrograde movement, and would be neither necessary or advisable if properly-prepared Buckwheat coal could be obtained at former prices.

For many years soft-coal miners have been urging upon consumers "run-of-mine" coal for steaming purposes, and within the last few years "run-of-mine" coal has been gaining favor, and in many districts has practically displaced screened coal as a steam fuel. By "run-of-mine" coal is meant coal as it comes from the mine, unscreened, and consisting of large and small lumps mixed with the slack coal. In a vast majority of cases screened coal is distinctly better than "run-of-mine" coal, as the screening takes out, not only the fine coal,—slack,—but also more or less fireclay and small fragments of slate. Screening, however, generally increases the cost more than it improves the quality. It leaves the miner with a large percentage of the mine yield in the form of slack, which is unmarketable and actually worthless, except possibly as coke. Hence the miner is forced to charge as much for the screened coal as he would charge for

* See article above quoted, in April number.

the same coal including the slack. For domestic and for certain special uses screened coal is worth its increased cost, but this is rarely true when the coal is used as a steam fuel.

The size and location of the plant may often exercise a governing influence upon the selection of the fuel. When the plant is small and the total cost of fuel not an important element, considerations of convenience and cleanliness may outweigh that of cost. These conditions obtaining at small plants in cities and towns, located near residences or at industrial works where smoke or soot is particularly objectionable, justify the consideration of anthracite coal, gas-works coke, or metallurgical coke (crushed or crude), which have merits especially commending them for use at such plants.

It is now many years since the use of pulverized coal as fuel for steam-making was first seriously proposed. In recent years much experimental work has been done in this direction, and the results, almost invariably, have been favorable to the adoption of this method of firing; but the introduction of many forms of mechanical stokers has retarded the development, and possibly prevented the adoption, of this method of burning coal. Pulverized coal has many of the fuel merits of oil or gas. Blown into the combustion chamber with a properly-regulated blast, it burns much as an oil or gas flame, enabling the engineer or fireman to regulate the fire accurately to varying steaming requirements. It goes without saying that, with proper regulation, smokeless combustion can be attained and maintained. As an offset to the advantages of such fuel we have the cost of pulverization, of which no reliable figures are yet obtainable. Possibly this will range between thirty and eighty cents per ton, depending upon the average size and hardness of the coal. The only use of pulverized coal as a fuel in practical work on a large scale with which the writer is familiar is that of replacing oil in firing the revolving kilns or furnaces used in burning cement. It seems entirely probable that at many establishments this method of burning coal might be used advantageously for steam-making.

While the calorimetric method for determining the thermal values of fuels is not well suited to the purposes of the engineer, in the absence of any other quick and inexpensive method it has been largely used for this purpose. The reason for the wide differences between theoretical calorific values and those attained in practical work have been sufficiently described in the article already referred to in the April number. It is evident that, under the average conditions of present practice, the calorimetric tests, in a majority of cases, fail not only to give a measure of value, but even to furnish a reliable means of comparing the actual relative values of a number of coals.

The various calorimeters are open to objections founded upon the small quantity of material used (from one to two grams of coal), the introduction of large personal errors due to the operator, the possibility of small thermometric errors causing large errors in the results, and the errors liable to occur in all apparatus requiring nice adjustment, perfect condition, and accurate handling. When proper precautions are taken to eliminate most of these possible sources of error, the instrument is doubtless scientifically accurate, and capable of closely determining the theoretical heating power or thermal value of any fuel. Such determinations do not, however, afford a satisfactory basis for deciding the choice of fuel, or for fixing the price which any fuel is worth as compared with other competitive fuels. The time will doubtless come when, in every-day steaming practice, the actual relative values of fuels will be realized, but, as this is rarely accomplished at present, relative values determined by calorimetric tests cannot always be relied upon in fuel-selection.

Some years ago the writer designed a model boiler plant to determine relative fuel values by actual evaporative tests with comparatively small samples, the minimum quantity of coal used in a test being about ten pounds, although any greater quantity could be used by prolonging the test. The water evaporated per pound of coal from and at 212° was directly determined by weight. The results attained by this means are not, perhaps, equal in value to steaming tests made on a large scale, but such tests can be made in many cases in which the cost of steaming tests is prohibitory, and, properly conducted, should furnish data more acceptable to the engineer or manager than those derived from calorimetric tests. The writer has now under construction an improved plant of this description, and will probably have it in operation at an early date,—possibly before this article goes to press.

In addition to the question of thermal values, other considerations of importance respecting the physical and chemical character of fuels may often be the deciding factors in determining choice. These relate mainly to the character and percentage of the ash and to the percentage of sulphur. Sulphur is, without doubt, the most objectionable constituent, a high percentage of water ranks next in order, and high ash is the least objectionable feature of fuel coals. As elaborated in the April article already referred to, the character of the ash, and the state in which the sulphur exists in coal, are as important as the percentages of ash and sulphur.

Other peculiarities of coal, among which may be noted their relative ability to bear transportation and rough handling, their deterioration from exposure to the weather,—"weather-waste,"—liability to spontaneous combustion in storage bins, etc., are of minor importance,

but in some cases may constitute the deciding factor in determining the selection of a fuel for steaming purposes.

Much of the heat generated by any fuel is unavoidably lost through radiation, and this loss is practically a constant factor irrespective of the character of the fuel; but the losses from imperfect combustion either of the fuel or of the gases generated by combustion vary widely with different fuels, and are necessarily largely affected by the character of the boiler setting, method of firing, construction of the combustion chamber, and atmospheric and other conditions of minor importance. In firing with gas (natural or artificial) or oil, these losses constitute a much smaller percentage of the theoretical thermal value of the fuel than when firing with solid fuels, and this accounts for the much higher duty obtained with liquid and gaseous fuels than with coal and wood. With all fuels containing a considerable percentage of hydrocarbons the desideratim is smokeless combustion. Owing to the regular feeding of fuel and uniformity of air supply possible when burning oil or gas, smokeless combustion, and nearly complete combustion of the gases without much excess of air, can be maintained. With ordinary coal or wood firing this is rarely accomplished, and the soot accumulating in or on the tubes reduces the efficiency of the plant. Large installations equipped with automatic stokers are able to show better relative results and a generally higher duty, approaching more nearly the efficiency of oil or gas firing; but there is still much room for improvement both in the manner and method of burning solid fuels.

GAS VERSUS ELECTRICITY FOR POWER TRANSMISSION.

By Nelson W. Perry.

DISREGARDING, for the present, the cost of production of the gas, let us see how transmission *per se* by this means and by means of the coal cart compare.

One ton of good anthracite contains about 29,000,000 thermal units. It will produce, say, 40,000 cubic feet of gas having 400,000 thermal units per thousand cubic feet, or 16,000,000 thermal units. The best a steam engine can do is to produce a horse-power hour on a consumption of 2 pounds of coal. The ton of coal will, therefore, represent about 1,000 h.-p. hours, and this has cost to transmit by means of the coal cart 54 cents, or .054 cent per h.-p. hour.

Our gas pipes have cost $16,000. If we allow $1 per foot for laying, including special work, the additional investment would be $15,000, making a total investment of $31,000 for the pipe line. Interest and depreciation on $31,000 at 10 per cent. is $3,100. This is for a pipe line capable of delivering 1,600 h.p., or $1.93 per h.p. Allowing 8,000 hours to the year, the interest charges would amount to 0.024 cents per h.-p. hour. The energy lost in transmission at 10 inches' pressure was found to be .07 per cent. of the power transmitted, or 1.12 h.-p. hours. If power costs to generate 1 cent per h.-p. hour, the transmission charges for 1,600 h.p. would be 1.12 cents, or .0,007 cent per h.-p. hour, which, added to the fixed charges, would make 0.031 cents per h.p. for gas as against .054 cent for the coal cart.

We have used, however, 1.8 tons of coal to produce its equivalent in calorific power of gas, which seems at first sight as though it would more than counterbalance the advantages in the transmission; but, when we consider that, after we have paid the gas company what it regards as a "reasonable" profit not only on the cost to manufacture its gas, but upon the cost of distribution, collecting, etc., we can, by burning that gas in a gas engine, produce electric light more cheaply than it can produce gas light, provided we do not have to distribute our energy again electrically; and that this excess light, if not charged with the cost of distribution, can be furnished at about half the cost that the gas light can be furnished for directly from the same gas,—it becomes apparent that, notwithstanding the inefficiency of the conversion of coal into gas, the advantages of gas transmission, very imperfectly represented by the above figures, are such as to give it preference.

The gas manufacturer, however, has this immense advantage over the steam or electric-power producer,—*viz.*, that he has at his command a most cheap and efficient method of storage, which enables him to keep his generating apparatus operating continuously at nearly its maximum efficiency. This means a minimum fixed investment and depreciation charge and insurance, and—what is quite as important—a minimum labor and administration charge and the almost total wiping-out of stand-by losses.

Compare this with the conditions under which an electric light and power station is operated. Naturally the gas-light load and the electric-light load are essentially the same, and, as it exists in this country, the maximum load is seldom less than two and a half times the mean load. The gas engineer's method of storage, which involves no appreciable loss in energy and permits him to draw upon it at any rate desirable with equal economy, costs very little, per unit of capacity, and decreases in cost very rapidly with the increase in capacity. By way of illustration I quote a few figures given to me by a large builder of gas tanks. A 500-foot holder would cost about $700; a 1,000-foot holder, $900 to $1,000; a 150,000-foot-holder, about $15,000; a 3,000,000-foot holder, about $180,000, or from $1.40 per cubic foot capacity=$35 per h.-p. hour capacity, for the smallest size, to 6 cents per cubic foot, or $1.50 per h.-p. hour capacity, for the largest size mentioned.

The electrical engineer, on the other hand, in order to store his energy, must incur by that step a loss of not less than 20 per cent. of the energy stored, and must pay for his storage battery at the rate of $30 per h.-p. hour, whether the capacity be large or small. The cost of maintenance and labor to keep the storage plant in effective condition is large, and the rate at which he may draw on his supply limited.

The efficiency with which the gas engineer can transmit his energy enables him to locate conveniently to the depot of supplies, and where also real estate is cheap; and thus and in other things his expenses are reduced to a minimum.

But, if the electrical engineer cannot transmit his power as economically as can the gas engineer, he can distribute it in a form far more generally available; and this, I conceive, is the peculiar province of electricity where comparatively short distances are involved,—*viz.*, distribution, pure and simple. The best results will be obtained, where comparatively short transmissions are concerned, by taking advantage of the economies of gas transmission, and then distributing electrically over short radii,—far shorter than are now usually supplied.

Dr. Louis Duncan, in his presidential address before the American Institute of Electrical Engineers,* speaking of this problem of electrical transmission, advocated the abandonment of the multi-station method, and the concentration of the generating plant into one single station. He said: "The question arises whether we have not reached a point where it will be more economical to consolidate the stations in the *best possible location* for economical production of energy, and make use of means of distribution which have been developed in the last few years to *increase* the radius at which energy can be supplied. We may conclude that, while the practice in large lighting and traction systems is to multiply stations near centers of consumption, yet the economy of a single large station makes it important to consider whether it is not possible to concentrate our power at some point where the expenses will be a minimum, and distribute by some of the methods which have in the last few years proved successful and economical." And, in speaking of distribution for electric traction, he says: "If direct distribution is attempted from a single station, it will be found that, when the distance exceeds five or six miles, a large amount of copper must be employed to prevent both excessive loss and excessive variation of potential on the lines. Even in the city itself the supplying of sections (of a road) at distances three or four miles from the station may require so much copper that it would be less expensive to operate separate stations. Suppose, now, that we wish to feed some suburban line where the load has considerable momentary fluctuations, but where the traffic is moderately constant during the year. In this case the booster could be used with a storage battery at the end of its feeder, the battery supplying the line. The advantages of this combination are greater than with the simple booster, and in many cases they will compensate for the interest and depreciation on the battery and the loss in it."

Dr. Duncan thus appreciates fully the difficulties in transmission which I have already pointed out in the first part of this article, and his remedy, though seemingly directly the reverse of the one I would suggest, is not so radically different as it at first appears.

He advocates the concentration of all the generating plant in one station conveniently located to fuel and water, and then, in order to keep its machinery operating constantly at its most efficient load, and for the purpose of economizing copper, the placing at the outlying points of storage-battery plants from which the local distribution would take place.

I have shown that energy may be transmitted for considerable distances in the potential form of gas far more cheaply that it can be

* "Present Status of the Distribution and Transmission of Electrical Energy."

transmitted electrically, and I would substitute the gas transmission for the electrical. In order that the pipe line might be utilized to its maximum efficiency, I, too, would recommend storage at outlying centers, but I have shown that even in a gas-tank of only 1,000 cubic feet capacity, the cost per h.-p. hour storage would be less than with a battery, and in larger sizes immeasurably less and without any attendant losses. Certainly no more ground will be required for the gas-tank than for the battery of equal capacity, and the attendance charges and depreciation for the gas-holder would be but a fraction of that for the battery.

I am not so sure, however, that the storage battery might not be used to good advantage in the gas transmission, thereby enabling us not only to dispense with the gas storage at the centers of distribution, but also to keep our dynamos and gas engines at those points, as well as our gas mains, operating constantly under the very best conditions. Under these circumstances a very large holder would be erected at the gas-generating plant, enabling us to operate our gas-producers on the mean load throughout thetwenty-four hours, and to take advantage of the very great economy of gas storage on a large scale as compared with an equivalent storage in a number of smaller holders.

Where I differ with Dr. Duncan most radically is regarding the distribution of the energy. Instead of attempting to *increase* the radius of distribution, I would increase the radius of transmission and *decrease* the radius of distribution. This would decrease the variation in pressure with the same amount of copper, or maintain the variation the same with a less amount of copper. Just how far this contraction of the radius of distribution and the consequent multiplication of centers would be economical would be a question to be settled by the conditions obtaining in each case, but that it could be done to advantage in many cases there seems to be little room for doubt.

As regards the gas engine, while it has by no means reached perfection, it possesses merits which more than counterbalance its defects; but there is a large amount of popular misinformation in regard to it. In the first place, it is generally believed that it is not, and cannot be, made in large sizes. That it is not made in large sizes is chiefly because larger sizes have not been demanded. English manufacturers have for several years announced that they were ready to make them in sizes of 1,000 h. p., if demanded.

Messrs. Dick, Kerr & Co. are reported to have constructed one of 600 h.-p., but of this no details are at hand. A 320-h.-p. engine (with fuel gas), or 450-h. p. (with illuminating gas), has been in operation for several years at the Pantin flour mills, near Paris. This is of the single-cylinder type, but, if made with two cylinders, its capacity

would be doubled. It has been engaged for over two years in operating the dynamos which light the mills, and other machinery.

It has been said that the larger-sized gas engines are not efficient or economical, but the facts seem to show the reverse. Mr. Dugald Clerk, in a paper on "Recent Developments in Gas Engines," read before the Institution of Civil Engineers, January 28, 1896, says that the actual indicated efficiency of a gas engine increases with the theoretical efficiency, and the actual efficiency varies between 45 and 58 per cent. of the theoretical efficiency, and the indicated efficiency increases with the dimensions of the engine, other things being similar, when the ratio of compression space, and therefore the theoretical efficiency, remains constant. Thus, he said, an engine having a cylinder 9½ inches in diameter with a length of stroke of 18 inches has a theoretical efficiency of 40 per cent. and gave an indicated efficiency of 19 per cent., or 47 per cent. of that theoretically attainable. An engine having a cylinder 14 inches in diameter with a length of stroke of 25 inches, of which the theoretical efficiency was 41, gave an actual efficiency of 27.7, or 67.5 per cent. of the theoretical efficiency. It was pointed out, however, that a limit was reached to the increase of efficiency due to increase of dimensions. But this efficiency is far in advance of that attained by any steam engine, if we include the boiler inefficiency.

It is popularly believed that the gas engine is less efficient at light loads than is the steam engine. This is not true when the two classes of engines have the same frictional losses; in fact, it is the other way, for in the gas engine there are no condensational losses such as form an important part of the inefficiency of steam engines at partial loads. In evidence of this I quote the tests made of a Crossley 80-h.-p. engine at the Bordeaux exposition, December 5, 1895.

"The engine in question was of 17-inch bore and 24-inch stroke, had one fly-wheel of 95⅜ inches diameter, weighing 17,600 pounds, and was adjusted to a speed of from 210 to 220 revolutions. The tests, which were carried on in the presence of one of the engineers of the Bordeaux gas-works, were made by belting the engine to a Thomson-Houston dynamo, and regulating the current by means of a liquid resistance. Owing to the weight of the fly-wheel, the voltmeter indicated no variation attributable to impulses from the piston.

First Test.

Loaded to about 80 horse-power:

Length of test	1 hour	15 min.
Gas consumption per hour	1316	cu. ft.
" " " kilowatt hour	32.1	" "
" " " indicated horse-power	13.7	" "

Second Test.

Loaded to about half capacity:

Gas consumption per hour.....872 cu. ft.
Indicated horse-power.....65.8
Gas consumption per kilowatt hour.....40.8 cu. ft.
" " " indicated horse-power.....13.24 " "

"*Remarks.* The gas-consumption per indicated horse power appeared to be slightly better with a reduced load, the difference, however, being but 3½ per cent.; but the indicator diagram was a little better than the average of the six others of the first test. It must be borne in mind, though, that the consumption per indicated horse-power of a gas engine changes but slightly with a change of load.

"The consumption per kilowatt hour would have been better if there had not been a heavy loss through grounds due to temporary installation and defective insulation of cables. Moreover, the belt was new, and the distance between centers of shafts quite short."

Many more tests might be cited to show that the gas engine maintains its efficiency at light loads in a way that will compare very favorably with the steam engine under similar conditions.

It is generally believed that it is difficult to govern a gas engine sufficiently closely to adapt it to electric-lighting purposes, and I believe this is true where the generators are of the alternating type and are run in parallel; but for direct-current purposes, with sufficient flywheel capacity, even single cylinder engines will supply perfectly steady lights at half load or less, and with double cylinders at still smaller loads. When used in connection with storage batteries, however, this nicety of governing is not so essential, and at the Belfast station, where batteries are used, the engines are belted directly to the dynamos.

The Belfast station, by the way, is the most interesting, in connection with our subject as thus far developed, that can be cited.

The system employed was decided upon by the corporation, on the recommendation of Prof. A. B. W. Kennedy. The equipment consists of six sets of rope-geared gas engines and dynamos. Four of these sets are for the general supply through feeders, and the remaining two, which are smaller, may be used either for this same purpose or for balancing the three-wire sections. The gas, which is an enriched water gas, is supplied from the city mains through two large meters. Four of the engines are of a maximum capacity of 120 i. h.p., and are used for driving four Siemens 60-kilowatt dynamos. The remaining two are coupled to Siemens 26.5-kilowatt dynamos.

The contractors guaranteed that the consumption of Belfast gas by these engines, when at their rated load, should not exceed 26

cubic feet per electrical h.p. per hour, as measured at the dynamo terminals. If 30,000 cubic feet of this gas can be produced from 1 ton of anthracite coal, this means an electrical h.-p. hour on less than 1.8 pounds of coal,—a better result, probably, than has ever been achieved by any steam engine. By a six-hour test at the contractors' works it was found that the consumption did not exceed 24 cubic feet, or 1.6 pounds of coal, and the combined $\frac{\text{E.H.P.}}{\text{I.H.P.}}$ efficiency proved to be about 76 per cent.

Thus far we have considered the conversion of our fuel into a carburetted water gas. Such conversion requires at the start a fair grade of coal, and, through the intermittent working necessary in all pure water-gas processes, a double set of generators. The greater cleanliness required of gas intended for illuminating purposes, and the carburation of the same in order to give the gas illuminating properties, add much to the expense of production.

Where gas is to be used solely for power purposes, a very much cheaper gas is in use, which is generally known by the generic term of Dowson gas. The process of making it consists simply of blowing, through a mass of ignited coal, superheated steam and air. This process is continuous, but makes a gas having a calorific power only about ¼ that of the carburetted water gas. It is, however, admirably adapted to gas-engine use, and is the fuel most employed in England and on the continent for this purpose.

By this process about 160,000 cubic feet can be obtained from 1 ton of good anthracite, and smaller quantities from inferior qualities of coal. While no more heat units are thus obtained from the ton of coal than by the other process, they are produced far more cheaply, and inferior and cheaper grades of coal, such as could not be used under boilers, may be used.

Dowson gas producers can be built for considerably less than the cheapest boilers; they take up less room, and their depreciation is less rapid. The attention required, too, is much less than with boilers of any class, so that, so far as the fixed charges, labor account, and cost of fuel are concerned, their economy is in marked contrast to that of the steam boiler.

As already stated, one of the most important items of expense in steam plants, when employed on variable loads, such as those of electric-lighting stations, is the stand-by losses,—the consumption of coal under the boilers while they are idle. This amounts to about ten per cent. of the total fuel consumed in an English lighting station, according to Prof. Kennedy, and probably amounts to not less than seven per cent. in those stations in this country having the best load line.

Mr. J. Emerson Dowson has very carefully determined the stand-by losses in a gas generator, and finds them so small as to be practically negligible. He built a portable generator, and placed it upon a weighing machine. In one case, after using this generator to supply 32 brake horse power, he left it on the scales with a fire in it, but without draft, for 18 hours in November. During that time there was a waste of but 18 pounds of coal.

At another time a generator which had been serving about 150 i.h.p., lost from 6 to 8 pounds per hour, and, on still another occasion, a larger generator, which had been serving from 250 to 300 i.h.p., lost 7.6 pounds per hour on standing 9 hours, and 3.9 lbs. per hour on standing 41 hours.

But even this insignificant stand-by loss is obviated where ample storage-tankage is supplied, for the fires are never banked, but are working continuously at their most economical rate.

Referring now to the results obtained from gas of this description, a test of the 320-h.-p. engine at the Pantin flour mills showed that, when working at 280 i. h. p. (220 b. h. p.), it consumed 1,295 ounces per i. h. p., or 1.03 pounds coal per b. h. p.

The consumption of water during the trials was at the rate of 1,342 gallons per hour for cooling the engine, and slightly less than 660 gallons for the washer and two generators. This gives a total of about 7½ gallons per brake horse power as against 44 to 55 gallons in the case of condensing engines.

In this country the largest gas-engine electric-lighting station is at Danbury, Conn. It has three 100-h.-p. engines operating on fuel gas. The conditions are most unfavorable for good returns, because the dynamos are not only very inefficient, being but 81.53 per cent., but operated through a jack shaft consuming over 35 h. p., according to tests by Mr. Charles E. Barry, and the size of the units is about the worst that could be conceived of to meet the lighting load of the station. In fact, a worse-planned station for electric lighting could scarcely be found anywhere, and yet the coal consumption per electrical h.-p. hour was, on full load, only 2.85 pounds, or at the rate of 262 watts per pound of coal.

But this fuel gas, while cheaper to produce, is more expensive to transmit than the illuminating gas, both because of its poorer fuel value (*viz.*, ¼) and because of its greater specific gravity (about .9). Four times as much gas must be transmitted, therefore, to represent the same energy, and, by reason of its greater specific gravity, the frictional losses under the same pressure and the same velocity will be greater. If the specific gravity were the same, it would require a pipe 20½ inches in diameter to transmit the energies calculated for the

different pressures in table I, and this alone would increase the investment for pipes from $16,000 to about $27,000, making the total investment for pipes laid about $42,000. As compared with the copper required to transmit the same energy at 10,000 volts with the same efficiency, this investment is still but about two-thirds as much, but the more serious effect of using the poorer gas is the decreased capacity of the gas engine using it, which is represented in the large French engine before referred to as the difference between 450 h. p. on illuminating gas and 320 h. p. on Dowson gas,—a decrease of over 29 per cent. For every horse power required, on illuminating gas, we would, therefore, have to instal about 1.4 h. p., if Dowson gas were used instead.

The high specific gravity of the Dowson gas would render a higher initial pressure necessary, even in a 20½-inch pipe, to deliver the same amount of energy, for, if with the illuminating gas we can deliver 40,000 cubic feet with an initial pressure of 10.46 inches of water, it would require a pipe of 23 inches to deliver the same amount of energy under the same pressure. Greater pressures, however, are permissible where gas is used for power purposes, so that economy of pipe may be effected by using them.

However, in transmitting a poor and heavy gas, the expense is increased in a large ratio, and it remains to be determined in each particular case whether the greater economy of transmission, and of gas-engine and storage capacity, involved in the use of a rich gas, does or does not counterbalance its greater first cost.

There is so wide a margin, however, between the cost and efficiency of transmission for short distances of power in the form of gas over the coal cart or the electrical means that it seems that for transmission within municipalities the gas-pipe has the lead.

One of the pet schemes of electricians to-day is the substitution of electric power for steam on our elevated railroads. But, so long as the elevated roads can carry their energy more cheaply than can the central-station man, I am convinced that electricity cannot compete in point of economy with the steam locomotive.

There are conveniences in the electrical method that may, and probably will, cause its substitution for steam on the elevated roads, in spite of its greater cost by present methods; but I believe that, if gas of a suitable quality were generated on the water-front and conveyed in pipes to gas engines located at frequent intervals along the route, and the energy distributed thence electrically, the electric motor would be found both cheaper and more convenient than steam.

SIX EXAMPLES OF SUCCESSFUL SHOP MANAGEMENT.

By Henry Roland.

II.

THE apples lay ruddy on the sward under the trees, the green leaves of the "sucker" tobacco were growing broad and long where the tall rows of the gentle herb had been cut in their bloom, and the dowager year, smug, plump, and lusty, enriched with all the wealth of departed summer, was demurely edging her garments with the pale purple of fall asters along the road-sides and meadow-edges, as I rode in late September over the trolley-line through that beautiful country between Hartford and South Manchester. The grass in the little valleys still showed the vivid autumnal green, and the trees were yet in full foliage, with here and there a maple beginning to redden, and the chestnuts and whitewoods and hickories and sassafras bushes to flaunt golden banners, so that, let the eye turn where it might, the vision was a dream of quiet beauty and gentle loveliness such as can hardly be equalled elsewhere in America. No park or ornamental ground ever matched the charm of this succession of low, wood-crowned hills and murmuring brooks, of small flower-sprinkled valleys and little green meadows, with just enough of long-ago-built farm-houses and old orchards to preserve the surpassing picture from that loneliness inseparable from a landscape without human habitation, however beautiful it may be.

Connecticut, as a whole, is a most beautiful piece of ground, and the stretch east of Hartford through South Manchester, where the Cheney silk-mills are located, is perhaps the most beautiful spot in Connecticut; and this beauty of the earth's surface at that place is, I believe, more potent than any other one agent in maintaining the harmonious relations existing between the Cheney management and its 2,500 workmen and workwomen, and in making the numerous members of the Cheney family content to remain now as closely resident owners as they were when in 1838 the four Cheney brothers,—Ward, Charles, Frank, and Rush,—impoverished by the bursting of the "Morus Multicaulis" bubble, returned to this charming scene of their boyhood days, and with difficulty gathered the few dollars needed to begin the manufacture of sewing-silk, with five or six girls at $2.50 per week as their entire force of workers.

The Cheney family is an old one in South Manchester, Timothy,

THE OLD CHENEY HOMESTEAD.

Benjamin, and Silas Cheney, three brothers, having farms side by side in Manchester in 1753. Timothy and Benjamin, in addition to being farmers, were makers of tall wooden clocks; the one example which I saw bears the name of Timothy on its dial, and now stands in a corner of the old homestead, located a short bow-shot to the eastward of the "lower mills," which was first built after the little sewing-silk-venture had expanded to the necessity of larger quarters.

John Fitch, whose invention of the steamboat preceded Fulton's conception of steam navigation, was an apprentice in Timothy Cheney's clock shop; Fulton has the honor of the application of steam to boat propulsion, and Fitch, though earlier in the field, is almost forgotten by the public.

In the latter part of last century Timothy Cheney moved from his farm, near the middle of South Manchester, to a new house, which he built near Hop-brook, where he had just erected a saw and grist and fulling mill, and in this old homestead Timothy Cheney died in 1795, leaving it to be occupied by his son George, whose sons were to inherit and exercise all the mechanical genius and business energy of their grandfather,—farmer, clock-maker, mill-owner, and man of affairs generally in the little community of South Manchester at the close of the eighteenth centnry. The children of George Cheney

A HOMESTEAD INTERIOR.

were George Wells, John, Charles, Ralph, Seth Wells, Ward, Rush, and Frank,—eight sons,—and Electa, a daughter.

In two of the boys the talent of Timothy Cheney developed itself along art lines, one becoming a successful and well-known painter, and the other one of the foremost steel engravers of his day.

The homestead itself, now more than a century old, low-eaved and many-gabled, full of family memorials in the way of portraits, old furniture, and paintings and engravings by the two artist brothers, is now kept as a show-place, inhabited only by care-takers, pensioners of the silk mills.

In 1836, that year of bubbles, when every cross-roads farm was laid out in town lots, and every land-owner was wealthy on paper, the silk-raising and "Morus Multicaulis" craze began.

In 1837 the bubble of land speculation burst, but the land itself remained, and the owners saw in the silk-worm scheme a way to make all their dreams of riches a reality. To plant and own mulberry trees and raise silk worms and sell cocoons was thought the sure road to wealth; "Morus Multicaulis" trees a year old sold for seven dollars apiece, and budding slips at twenty-five dollars a dozen. Countless acres were planted with young mulberry trees, on the leaves of which millions of silk-worms were to feed, preparatory to the spinning of cocoons in endless succession, the sale of which was to enrich every owner of a mulberry orchard. Charles Cheney started a mulberry-tree nursery on a farm which he owned in Ohio, and Ward, Frank, and Rush Cheney did the same on their farm at Burlington, New Jersey, where they also published a paper,—*The Silk-Grower's and Farmer's Manual.*

In 1839 and 1840 the Cheney brothers had not one mulberry tree left, and had plenty of money in the United States Bank in Philadelphia. In 1841 the bubble burst, and all the possessions of the four Cheney brothers gained from the mulberry business were used to satisfy their creditors, and Charles, Ward, Frank, and Rush Cheney came back to the homestead in South Manchester a little less than even

with the world, so far as money was concerned,—the youngest of them at that time about thirty-five years of age,—to begin the manufacture of sewing silk on the smallest possible scale, and with great difficulty, and, as events have proved, to lay the foundation of one of the largest and most successful silk manufactories in the world. At that time, 1841, the grist, saw, and fulling mill of Timothy Cheney had passed into other hands, and was occupied as a paper mill. His four grandsons began their silk-making in a little building a short distance west of the Cheney mill on Hop-brook. Sewing-silk had been previously made in New England, and machinery for its production was bought, and the little mill started, driven by water power of course, and with a few of the neighboring farmers' daughters to operate the little plant. Here in the little mill the brothers labored early and late, adding new improvements devised by their own fertile brains, making excellent sewing-silk and finding a ready sale for their product. It may well be believed that, with the timorous expectation born of failure, the great success of the silk mill was far beyond the brightest hopes of these four brothers, and certain it is that never for one moment, from that day to this, have the attention and painstaking personal supervision of the Cheneys been relaxed. Two of the four brothers still survive,—old men, no longer in active direction of the affairs of the mills, which are now conducted by their sons, each of whom, after completing his education (always thorough in a chosen line and often including a college graduation), takes the lowest place in some department of the mills at the lowest wages paid in that department, and advances only as his ability and actual worth to the concern warrant. There are to-day eighteen of the Cheney name in the establishment, which is managed as exclusively by Cheneys as in the days of the original mill.

THE OFFICES AND A GLIMPSE OF THE MILLS.

From the first success was rapid. Building after building was added near the first shop site, now known as the "old mills," and two other groups of mills, known as the "lower mills" and the "weaving and spinning mills," have been added in South Manchester; besides which a mill weaving narrow goods has been built in Hartford. The Cheneys were among the first to begin the manufacture of spun silk, and this branch of the art of silk manipulation they have carried farther and to a more extensive and profitable development than any other manufacturer. The Cheney mills at present have about eighteen acres of floor-space, are driven by 2,500 h. p. of steam engines, and employ about 2,500 hands, half of them women. The works, ornamental grounds, Cheney residences, and the workmen's homes occupy about 1,000 acres of ground in South Manchester. In

THE SPINNING AND WEAVING MILLS.

1851 the business was consolidated into a close corporation under the name of "Cheney Brothers," with $1,000,000 capital. No increase of capital stock has been made; there are no reports of dividends, no sales of stock,—nothing save constant growth, peace, and prosperity of all concerned. The lowest estimate placed on the value of the stock by those well informed is four for one; the highest, seven for one. About 1891, the water-supply being inadequate, the company bought the manufacturing establishments on Hop-brook, tore them down, and passed all the head waters of the stream, first into a settling basin and filter bed, and then into a 50,000,000-gallon-capacity reservoir, 240 feet above the level of South Manchester. Hop-brook watershed is in a hilly country almost entirely uninhabited, and the

THE RESERVOIR.

South Manchester water is of excellent quality. There are other sources of water-supply for some departments of the mills, the waters of a large spring of exceptional purity being led to the dye-houses where the more delicate shades are produced. South Manchester is about two miles south of North Manchester, a station on the New England road; about 1860 the Cheney company built a private rail-

THE SETTLING BASIN.

The filter consists of three feet of coarse hill-sand, laid on stone and drain-tiles.

way from South to North Manchester; nine daily trains connect, and through cars are run from and to South Manchester. The other industries are principally small paper mills, and these are now disappearing, so that the silk mills are making yearly approaches to complete isolation.

At first the "help" was exclusively of home production, and one of the most serious differences of opinion between the management and the hands came with the first employment of Irish girls. The "native born" held themselves high above "Irish Catholics," although there are no women in the world more industrious and capable, or more deserving of esteem for the exercise of all the virtues, than Irish girls. The principal trouble was over religion, the Yankee girl of forty years ago retaining a share of the Quaker-whipping, witch-burning, Puritan proclivities, and regarding a Roman Catholic with horror. All of this has disappeared long ago; the religions and politics of South Manchester are what might be expected in a mixed community of American, English, Irish, Scotch, German, and Swedish nativity. The management imposes no restriction of any sort upon its workers. There is no organization of labor, and "no representation of labor" in the business. Wages are paid almost wholly on the piece-work plan. For a certain prosperous year, when times were

FRONT OF SPINNING AND WEAVING MILLS.

STATION ON THE CHENEY PRIVATE RAILROAD.

"good," the average pay in various departments was as follows:

	Males.	Per week.	Females.
Raw Silk Winders	.....	....	$6.00
" " Cleaners	.....	....	4.25
" " Doublers	.....	....	5.75
" " Spinners	$10.00	...	5.75
" " Twisters	10.00	....	5.75
Soft " Winders	7.00	....	6.30
" " Spoolers	....	....	5.00
" " Warpers	10.50	...	6.50
" " Warp twisters	18.00	....	....
Weaving Broad goods	11.84	....	8.80
" Ribbons	9.00	....	7.00
Designers	25.00	....	....
Card cutters	18.00	....	....
Dyers	9.00	....	....
Finishers	12.00	....	....
Laborers	$7.50 to 9.00	....	....

The low pay was given as $3.50 per week.

In this year there were, out of 2,500 hands employed,

88 men obtaining weekly $10 to $12.
104 " " " 12 " 15.
96 " " " 15 " 20.
24 " " " 20 " 25.
46 " " " $25 and over.

A WORKMAN'S COTTAGE.

The high women's pay was given in that year as, in the case of one woman, over $12 and under $15, the next highest being that of 37 women, whose wages were over $7 and under $8 per week.

These wages are, I believe, better than cotton-mill workers obtain, but not so great as to be very tempting to the mass of American toilers. Out of 2,500 hands the total number obtaining over $10 weekly is only 358, leaving, say, 2,242 paid over $3.50 and under $10 weekly. As about half of the workers are males, it seems likely that the average skilled workman's pay is not over $8 or $9 per week.

Some, not many, of the retired workers are pensioned. There are many hands in the mills who have been in service for forty years and over. The company owns about two hundred rented tenements of a very superior class; the rents vary from $5 per month up to $12 and $14. The tenements are widely-separated cottages. The difference in price is due mainly to location; there are "aristocratic" and "plebeian" workmen's quarters among the company's tenements, besides which nearness to the works and other considerations make some locations more desirable than others. In cases of hardship, such as sickness or long-continued short-time, concessions are made, rents written off, and straight-out charity bestowed, although giving of money is very strongly deprecated by the management. "Once give

out money, and you make a perpetual pensioner," was the way it was expressed.

"Any one can do what we have done," said one of the Frank Cheneys to me; "let any man, or two or three men, take any sound business, start small, do good work, and give their whole time and attention to the business, and put every dollar it earns back into the establishment, excepting only a fair salary for the actual work done by the managers, and they must succeed. That was all the Cheneys did: we have made no great or controling invention; we have not originated any methods of startling novelty; we have kept ourselves informed; we have used what faculties we had; we have all lived right here, with our help about us, and treated them fairly. We do not pay high wages; we do not share profits; we have never heard of any plan which in our judgment would better our present course of operation. The children of our workmen often go into the mills. Some of our help goes away; most of it comes back, homesick. We encourage workmen to own homes. We sell land at from one to two cents per square foot, according to location. We have here in South Manchester a strong building and loan association, which has many of our workers among its members. We never took care of the savings of our help, and there is no savings-bank here; Hartford has the nearest. When a man has a

A WORKMAN'S COTTAGE.

home and a wife and a little furniture, and is comfortably situated, he is not likely to make any change." "Yes," was said in answer to a question, "we have had some disagreements; they cannot be avoided; but nothing has ever led to any serious trouble. We object to the sale of liquor, and the town is sometimes 'dry' and sometimes 'wet'; this year it is 'wet,' and we have about twenty licensed drinking-places, but there is a good deal of liquor sold here when the town is 'dry.'"

Another Frank Cheney believes that isolation is the principal cause of the harmony existing in the Cheney silk mills. This speaker also very strongly favored prohibition.

Neither of these gentlemen laid much stress on the beautiful sur-

CHENEY HALL.

roundings of the South Manchester homes. The "Park," or grounds, in which both the factories and the Cheney residences stand is about one hundred acres in extent, and is beautiful beyond description, with a quiet loveliness and all the charms which nature, vivid and vivifying, can exercise upon mind and heart.

The dwellings of the workmen are contiguous, and have a similar environment. The Cheneys themselves are contented to pass their lives in South Manchester, because they can nowhere else find so delightful a harborage. The workmen remain for the same reason, and because their time is full of light labors, with simple enjoyments in easy reach. Cheney Hall is a free assembly-room, with ample accommodations for gatherings of all kinds. It is located just one side

A GROUP OF CHENEY RESIDENCES.

THE NINTH DISTRICT-SCHOOL BUILDING.

of the middle of the works, and, in effect, is the sole property of the help. The Cheneys built it, heat and light it, and pay a janitor two dollars a day to take care of it, and the hands use it at will. It is constantly in service.

The Cheney School is conducted on admirable lines, devised by Secretary Charles D. Hine of the State board of education; it is located in the ninth school district, which had in 1894 an enumeration of 1,003 pupils; the school was built by the Cheney corporation, and its use given, rent free, to the district. It has provision for a large kindergarten, a workshop, a gymnasium, and a cooking school, and there are large collections of books in each of the rooms, which are very numerous and used for not more than twenty-five pupils each. Children are taken in the kindergarten at the age of three years; wood-working and mechanical drawing are taught in the workshop. The educational course is thorough, varied, and high enough to meet the requirements of the most ambitious pupil.

One of the Frank Cheneys, who drove out to the reservoir and settling basin with me, a young man who can choose his own life, chooses to be mechanical director of the establishment, and personally conduct the machine shop; his pleasures are those of the horologist, Timothy, and his delight is the delight of his father, now near fourscore, who said to me: "It is a great pleasure to work." The wood through which the reservoir road lay was beautiful with autumn foliage, and, in response to my expressions of admiration, this Frank

Cheney said that he had seen no place in the world save New England where he would care to live, and, of all of New England that he had seen, South Manchester was to him most desirable as a place of residence.

It is so with the Cheney hands; they are healthy and happy; they live now in so beautiful surroundings that no change can improve them, and those who try a change to Paterson or the other silk-manufacturing places very seldom stay long away. For the young workmen their work by day and the full social possibilities found in a constant succession of lodge meetings and social events fill their minds. The older men see their wives in comfortable homes and their children in one of the best schools in the world; the unmarried, of whom there are considerable numbers of either sex, have the life they choose to have; what more need be said?

South Manchester is not so strait-laced as Whitinsville, and it is possible that the management at South Manchester is something less of a special providence to each separate individual than at Whitinsville; in both places the women walk with elastic steps and wear red in their cheeks; easy work, pure water, fresh air, and comfortable homes are the common lot; what could these workers expect to gain by change?

From the beginning the Cheney mills have had a finely-equipped machine shop and skilful and ingenious workmen. Christopher M. Spencer, inventor of the Spencer automatic screw machine, of which

A GROUP OF SCHOOL-CHILDREN.

a thousand are in use by the Hartford Machine Screw Company alone, was one of the Cheney shop-foremen. He is also the inventor of the Spencer rifle, over 100,000 of which were in the field in the last year of the war of the rebellion. The Spencer rifle was fostered and developed by the Cheney management, which at one time had half a million dollars written on the wrong side of the rifle account; but the last year of the rebellion the Spencer rifle factory in Boston, under the management of one of the Cheney Brothers, ran on an open order for unlimited production, and made money to about balance the ledger. The "Grant reel," invented by Mr. J. M. Grant, who was

THE MACHINE SHOP.

for about forty years one of the Cheney workmen, is now largely used in European silk works as well as in China and Japan. These are examples of the more prominent novelties emanating from the Cheney establishment, but, taking the business as a whole, its great success has not been due to any series of great and revolutionizing inventions, but, rather, to a constant series of small detail improvements, coupled with unremitting personal attention and that thorough personal knowledge of every detail of silk manufacturing gained by the actual performance of workmen's duties which has been in all cases a part of the education of the Cheney managers.

The Whitin Iron Works and Cheney Silk Mills show the very great advantages of isolated manufacturing plants and resident owners and managers, each thoroughly familiar with some branch of the operations carried on. Isolation gives opportunity for beautiful surroundings, pure air, and agreeable living conditions, which make the workers healthy, happy, and contented, and also reduce the workmen's living expenses to the lowest terms, and favor the growth and education of successive generations inclined by heredity to become efficient and docile operatives. It would be difficult, indeed, to content the Whitinsville or South Manchester employees with homes and home-surroundings afforded by the sordid tenement-houses and treeless, unlovely streets of the tenement districts of any of our large manufacturing centers, and it is extremely improbable that any "labor agitator" can ever succeed in "organizing" the workmen of such an environment as that which obtains in Whitinsville and South Manchester. At South Manchester, when the Knights of Labor were at the height of their prosperity, a lodge was organized, but it died a natural death without the slightest interference by the Cheney management. There are too many agreeable social diversions at South Manchester to make the dreary mouthings of the professional labor agitator an attractive entertainment, and, without the professional labor agitator, the paid "walking delegate," the paid "committee of adjustment," and all that horde of labor parasites which subsists on labor troubles, organized strikes become impossible. Hence lightly-worked hands, who have life enough left at the close of the day's labor to take part in some social amusement, and who have means to please themselves, lend a deaf ear to the blatherings of the labor-dissension "hireling," and turn with disgust from the prospect of a contest with their employers. Undoubtedly isolation, beauty and healthfulness of surroundings, and the ready means of amusement furnished by Memorial Hall in Whitinsville and Cheney Hall in South Manchester are the principal factors in the harmony with which labor and capital combine their efforts for mutual good at the Whitin Iron Works and Cheney Silk Mills. These means are not available in a mural environment, and two of the six examples of successful management to be treated in this series of articles will show the totally different means by which establishments located in cities are enabled to reach equally harmonious and desirable relations with their workmen. Without question, however, taking the greatest good of the workman and his family and the lowest possible cash cost of product as the chief desirabilities of attainment, these two examples very strongly indicate isolation as the ideal condition for manufacturing purposes.

THE RELATION OF INVENTION AND DESIGN TO MECHANICAL PROGRESS.

By C. L. Redfield.

THE expression, "mechanical progress," as here used, may be defined as "progress in the science and art of utilizing the forces and materials of nature in the construction of machines."

Such progress is of four kinds: first, the discovery of new laws, forces, and materials; second, the invention of new ways of utilizing what has been discovered; third, improvement in the design of structures embodying inventions; fourth, increased skill in the making and handling of what has been designed. These are well-defined divisions, and each calls for a peculiar quality or action of mind. So distinct are they that it is not common to find a person who is master of more than one of them, though they are not incompatible with each other for one having the proper education and training.

Discovery is not an active mental operation, but an exercise of alertness in observation. Invention, on the other hand, is a purely intellectual process that seeks to combine forces and bodies so as to produce new results. Design is the product of a knowledge of the laws and materials of nature joined to a sense of the fitness of things. Skill is an acquirement attained by practice upon one thing or class of things. Of these four elements relating to the progress of mechanics, invention and design are most intimately associated with each other. Discovery is more closely connected with invention than with design; skill more closely with design than with invention. All are more or less interdependent, and each at times makes use of the others in its development.

The discovery of new laws, forces, and materials is not common at the present time. What there is of discovery is principally confined to finding new results of known laws, and is invoked as an aid to invention and design. This is not due to a scarcity of individuals who would make competent discoverers, if there were a large and remunerative field for their services, but to the fact that it pays better to do something else. Too many discoverers, whose capacity does not warrant them in going beyond their legitimate field of operations, are engaged in the work of invention, in the fond belief that they are inventors. Not a few of them are successful, but it is not because they ever invented anything, though the law gives them credit for having done so.

"Striking it right" is not the act of an inventor, but that of a discoverer, who, by the mere multiplicity of attempts, insures the ultimate finding of the right way, provided his money and patience, or that of his backers, do not give out. This discovery of invention—if I may be permitted to use so paradoxical a term—is not a little assisted by suggestions from others, which tend to guide the experiments into the right path.

The discoverer who becomes successful in invention in time learns wisdom, and, instead of going through endless experiments, employs another to make the invention he wants. This practice, while legally permissible, is ethically wrong, in that it gives the work of the actual inventor to a person who merely had an idea that such an invention would be valuable. In saying this, I do not wish to be understood as impugning the motives of those who indulge in this practice. They doubtless believe themselves the actual inventors, and the conversation of their friends and attorneys strengthens that belief.

I have said that invention is a purely mental process. It is also a mental process of a peculiar kind, though by no means rare. The inventive faculty, so called, is possessed by thousands who make no pretensions to it, and who know almost nothing of mechanics. It is essentially imaginative, and is practically identical with that which produces the plots of plays and novels, and the theories and hypotheses of science. In its practical application, invention is like the solution of a puzzle,—a struggle to do what one knows not how to do.

Invention, *per se*, does not require an extended knowledge of mechanics, but some familiarity with the laws of nature is essential to the making of any invention, and, the greater this familiarity, the more effective and skilful the inventor will become. In making this statement, a distinction is drawn between mechanics and the laws of nature. The former has reference to what man has made, the latter to mechanical principles in the abstract. Studying the laws of nature necessarily involves studying the works of man, and there is a point, determined by the mental capacity of each individual, beyond which increased learning in mechanics is positively detrimental to the ability to make inventions. This is particularly true when learning takes the form of exhaustive study of what has been made by others, and the lines along which others have worked. Study of this kind tends to narrow, instead of broaden, the mind, and to get the individual into a rut from which he cannot escape. This may be illustrated by a circumstance taken from the commercial history of Great Britain. For many years England has had control of India, and her ships have carried the manufactures of the occident to exchange for the products of the orient. When this trade first became valuable, efforts were con-

tinually made to reduce the time during which goods were held in transit. To accomplish this, larger and finer vessels were built, and were equipped with better rigging or more powerful machinery, and the science of navigation was utilized to its limit. When this had reached a stage where it became evident that further progress in the economy of time would be slow, a man who knew nothing of navigation, and next to nothing of naval architecture and steam engineering, came forward, and, by cutting a canal across the isthmus of Suez, made it possible to take any old tub of a boat from England to India in less time than the swiftest vessel afloat could ever hope to go in the old way. Study of the laws of storms, practice in the art of navigation, improvements in the contour of ships, and inventions relating to marine engines would never have cut that canal, and, the more strictly the minds of engineers and navigators were centered on these things, the less likely they were to evolve that short route. The simple cutting of a canal is not invention, but its construction in connection with the purposes for which this one was made accurately illustrates what invention is.

Design bears about the same relationship to invention that skill in literary composition bears to the story to be told. In its common acceptance, it is supposed to relate to the form and shape of pieces; but it goes further than this, taking in the arrangement of parts and their coöperation, one with another. In this work it often encroaches upon invention by producing new and useful results. Design does not call for the same degree of imagination that invention does, but it requires a more thorough knowledge of physical laws and a sense of the artistic. The inventor is not usually a designer, though he may be. Many inventors without the designer's qualifications are acting as designers in respect to their own inventions. Inventions dressed in crude garb represent only the foundation on which design constructs that which truly represents progress progress in mechanics.

Design applied to machines is a comparatively new and untaught art, and few have mastered its intricacies sufficiently to enable them to produce good work, pleasing and adapted to the materials used. Ornamentation of the kind employed in other arts is not generally applicable to cast iron, and cast iron is the material in which the majority of designs are executed. The stag is a handsome, graceful, and well-built animal, and his head is crowned with a pair of antlers that are both useful and ornamental, but, if his legs had been constructed on the plan of his horns, he would have been extinct ages ago. How little some of our would-be designers understand what is appropriate can be seen from the numerous lines of machines which are supplied with legs that look as if they were patterned after the horns of a deer.

A machine is preëminently an article of use. Therefore correct design in a machine requires that each part should take that form which is best adapted to its use, and an outline that will indicate the character of its use. This requirement of the details is qualified to the extent that no piece should be of such form and construction as to be out of harmony with the whole. The worst and most objectionable feature of many machines is that certain parts give the appearance of having been after-thoughts. No design can be true that does not previously contemplate all parts of a machine, and bring each into its proper relationship to the others. It, therefore, follows that the designer should have in his mind at the outset a complete understanding of its operation, its uses, and the conditions to which it will be subjected. Premising these conditions, and skill on the part of the designer, the result will represent satisfactory progress.

Design in architecture rests upon well-established traditions as to what is excellent, and is carried out by persons trained and educated in the art. Design in machinery has no such foundation, being, for the most part, in the hands of comparatively young and inexperienced men,—men between the ages of twenty and thirty. Reason for this is found in the fact that the value of excellent designs is not generally appreciated, and certainly not appreciated as it should be. The result is that designing, as a profession, receives scant remuneration, and, as the man who is competent to become a good designer is also competent to become something else, he soon drifts into other channels.

In spite of all handicaps, there is a steady improvement in the quality of machine-design. At present we find this improvement in forms and shapes that are at once pleasing to the eye and satisfactory to the sense of fitness. Forms and contours that are good and proper have something intrinsic that conveys that impression to the beholder, even when he has but a slight knowledge of the qualities of the materials in which the design is executed and but an imperfect sense of the artistic.

Of all the forms produced in machine design there seem to be but two that deserve to be perpetuated. One is what may be designated as the hollow pedestal, and is well illustrated in shapers and milling machines. Rounds and ovals harmonize with this, as do all massive forms that have a smooth and unbroken exterior. The other may be called the I-beam form, and is especially applicable to frame-work. In many cases it gives the best possible distribution of metal, and produces an appearance of beaded panel work. Sections in the form of crosses, Ts, and Ls, harmonize with this, as do smooth surfaces when they terminate in pronounced beads. The massive or pedestal form is applicable to straight lines or long sweeping curves, as is illustrated

in punching-machines and the Porter-Allen engine and its copies. The panel, or I-beam, form should never have the sweeping curve on more than one side of a given panel, and then only when it serves a distinct purpose of which the outline gives evidence. Curved legs, whether of the I, T, L, or hollow form, are obviously wrong, because their outline does not correspond with the lines of force that they are intended to resist.

An illustration has been given of how invention outstripped design in carrying ships quickly from England to India. On the other hand, if we carefully compare the ocean greyhound of to-day with the dug-out of primitive times, we will find that nearly all that goes to make up the difference is the product of design, and not of invention. Again, James Watt built engines a hundred years ago, and we build engines to-day. Numerous and important inventions relating to steam engineering have been made since the days of Watt, yet our engines are not more durable, and scarcely more economical, than those prototypes. They are, however, of better form and more convenient, and they furnish more power for their size and weight. These results are principally due to improvements in design, and to designers should be given the credit.

We have the well-recognized professions of doctor, lawyer, minister, engineer, and chemist, and we have schools for the education and training of each; not so with designers of machinery and mechanical appliances. Individual designers we have, but their number is few. As a result, improvements in design are sporadic, and often have their origin in accident or sudden inspiration. Once a design is made, its excellence is quickly recognized and largely copied. This copying of design may, in the absence of a sufficient number of competent designers, be beneficial to mechanics in general, but it is a source of much complaint from those who have their designs so copied. The justice of such complaints may be questioned, not because the copyist has any right, legal or honorable, to appropriate the product of another's brain and skill, but because the very person who makes the complaint is often guilty of claiming as his own that which was in reality made by some one else,—probably some poorly-paid draughtsman. When manufacturers of machinery shall properly compensate skilful designers, and give credit where credit is due, then the best talent will be drawn into this art, and copying will cease. There is no more reason why the originator of an excellent design should not receive credit for his skill than why an author should not receive credit for what he produces.

Invention is analogous to the plot of a story or the ideas and sentiments of an essay; design finds its counterpart in the phraseology and

manner in which the story is told or the ideas and sentiments conveyed. Literature covers the story and the way it is told, and mechanics covers the invention and the design through which it is carried out. Many stories may be told from a single set of characters, and each story may be told in many different ways. Many inventions may be founded on a single discovery, and many designs may be made for carrying out a single invention.

Inventors we have, and always will have. They are a natural product, needing but the stimulus of incentive to bring forth their best efforts. This stimulus exists in the form of patent laws framed for their protection and benefit. Designers we have not; neither are they a natural product; they must be raised, trained, and educated. We have no schools for their training, and we furnish no incentive for their development, nor do we give encouragement and credit to those who enter the field. Yet it is from designers—designers of machinery—that we must expect the most substantial part of our future progress in mechanics.

While it is true that designers are not born, but educated, it is also true that the successful designer must be born with some qualities of mind that all persons do not possess. First, he should have a sense of the appropriate; second, he should have a capacity for acquiring special and general information; third, he should have the faculty of observing and perceiving what is and has been done; fourth, he should have the ability to control the other elements with judgment and common sense.

Premising these qualities in our prospective designer, how shall we educate him? Whatever plan or course be adopted, he should not be subjected too rigidly to rules and precedents; else he will become dogmatic in theory and a copyist in practice. The ideal designer is bold in conception and conservative in action. He studies the forms of nature, and adapts them to the practice of man. He analyzes the work of his predecessors, and compares it with natural forms, and he seeks the reasons why natural forms are as they are. But this is not all. Many forms that are desirable in themselves are impossible of construction with our present appliances, or so costly as to be prohibitive, except as works of art. The ever-present question of dollars and cents, and the fact that designs involving dynamics are different from those involving statics only, compel our student to carefully consider what can, and what can not, be made, and the relative cost of making things in different ways. The study of these things will send him to the pattern, machine, blacksmith, and boiler shops, to the foundry and the rolling-mill; on the thoroughness with which he comprehends the processes employed will depend his future usefulness.

ABSENCE OF A STANDARD IN BATTLE-SHIP DESIGN.

By Ridgely Hunt.

THE purpose for which a battle-ship is designed, built, armed, and put in commission is to fight on the high sea against some other battle-ship. It follows, therefore, that, in each ship constructed for this purpose, the attempt is made to have her the superior of any enemy's battle-ship she may be called on to encounter. In examining the attempts of naval experts to put afloat an impregnable vessel possessed of the highest powers both of offence and defence, little agreement in regard to some of the most important particulars is observable; hence, until battle-ship meets battle-ship in mortal combat, no just estimate of the superiority of the distinctive features of the one over those of the other can be properly made.

To select an ideal ship as a standard and measure the efficiency of existing ships by her is objectionable. For instance, there are some well-informed men who believe that a 10-inch gun is the largest piece a battle-ship should mount; other experts, quite as capable, advocate 13-inch, or even larger guns. A like diversity of opinion is noticeable in regard to the thickness and the distribution of the armor; and the same is true concerning the speed. In short, scarcely a single feature is accepted without more or less condemnation. The result of so divergent views can be best appreciated by overhauling the data of the latest and presumably the best-designed battle-ships now being built by the principal naval powers of the world.

Of course, everything superlative is not to be found in a single ship; the aim is to so compromise the desiderata as to secure the best possible. Size is a good element in a battle-ship; it insures the best sea-keeping and sea-going qualities and the best speed. Besides, it permits of almost any distribution and thickness of armor and the emplacement of the most powerful armament. But beyond certain limits great size is impracticable. The expense of construction and afterwards of maintenance, the unwieldiness of such masses, and the size of dry docks are some of the deterrents; and the depth of water to be found in most of the harbors of the world is another serious obstacle. Finally, there is no certainty that a torpedo might not, by a single successful blow, destroy the whole expensive structure.

The following table gives dimensions and other particulars of the typical ships now occupying the attention of the navies of the world.

Name	Armament.	Foot tons of muzzle energy per gun.	Rounds per minute.	Total energy in ft. of each class of gun per minute of fire.	Energy per ton of displac'mt
MAGNIFICENT	4 12	33,900	⅛	22,600	
	12 6	3,360	30	100,800	
	16 12 Pdr	425	160	68,000	
	12 3 Pdr	80	144	11,520	13.6
	44	37,765	334⅛	202,920	
ROYAL SOVEREIGN	4 13.5	36,000	⅛	24,000	
	10 6	3,360	25	84,000	
	16 6 Pdr	280	176	49,280	
	9 3 Pdr	80	108	8,640	11.6
	39	39,720	309⅛	165,920	
RENOWN	4 10	14,430	⅛	9,620	
	10 6	3,360	25	84,000	
	8 12 Pdr	425	80	34,000	11 2
	12 3 Pdr	80	144	11,420	
	34	18,295	249⅛	139,040	
CHARLEMAGNE	4 11.8	30,000	⅛	20,000	
	10 5.5	3,300	50	165,000	
	6 4	500	51	25,500	20.0
	16 3 Pdr	80	192	15,360	
	36	33,880	293⅛	225,860	
CARNOT	2 11.8	30,000	⅛	10,000	
	2 11	22,750	⅛	7,583	
	8 5.5	3,300	40	132,000	
	4 6 Pdr	280	44	12,320	14.7
	16 3 Pdr	80	192	15,360	
	32	56,410	276⅛	177,263	
E. FILIBERTO	4 10	14,430	⅛	9,620	
	8 6	3,360	20	67,200	
	8 5	1,100	52	57,200	16.2
	8 6 Pdr	280	88	24,640	
	28	19,170	160⅛	158,660	

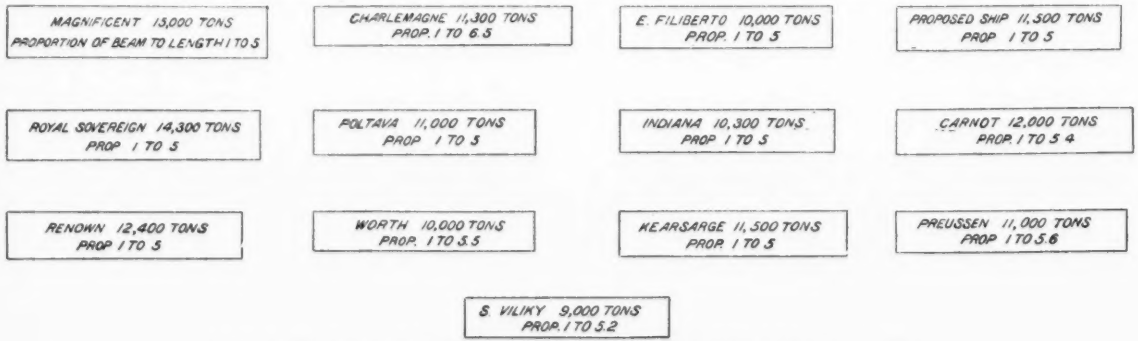
Name.	Armament.	Foot tons of muzzle energy per gun.	Rounds per minute.	Total energy in ft. of each class of gun per minute of fire.	Energy per ton of displac'mt
WÖRTH	6 11	22,750	1	22,750	
	6 4	500	51	25,500	
	4 3 5	440	40	17,600	9.0
	8 6 Pdr	280	88	24,640	
	24	23,970	180	90,490	
PREUSSEN	4 10	14,430	⅛	9,620	
	18 6	3,360	45	151,200	
	12 3 5	440	120	52,800	21.6
	24 3 Pdr	80	288	23,040	
	58	18,310	453⅛	236,660	
S. VILIKY	4 12	33,900	⅛	22,600	
	6 6	3,360	15	50,400	
	12 3 Pdr	80	144	11,520	29.4
	22	37,340	159⅛	84,520	
POLTAVA	4 12	33,900	⅛	22,600	
	12 6	3,360	30	100,800	
	10 3 Pdr	80	120	9,600	12
	26	37,340	150⅛	133,000	
INDIANA	4 13	34,000	⅛	22,666	
	8 8	8,100	2 6	21,060	
	4 6	3,360	10	33,600	12.3
	16 6 Pdr	280	176	49,280	
	32	45,740	212⅛	126,606	
KEARSARGE	4 13	34,000	⅛	22,666	
	4 8	8,100	1 3	10,530	20 5
	14 5	1,800	91	153,800	
	16 6 Pdr	280	176	49,280	
	38	44,180	269	236,276	
PROPOSED SHIP	4 13	34,000	⅛	22,666	
	14 6	3,360	35	117,600	16.5
	16 6 Pdr	280	176	49,280	
	34	37,640	211⅛	189,546	

Great Britain is building the largest-sized battle-ships; elsewhere 10,000 and 12,000 tons are, for the time being, the limits. These figures, excepting in Italy's new ships, have been reached by gradually enlarging each succeeding ship, and there is no reason to take them as final. In order to show graphically the relation existing between the sizes of the battle-ships now being built, the accompanying diagrams are submitted; assuming that the drafts are equal, the length and breadth of the rectangle respectively represent the length and beam of the ship, and the area, the displacement tonnage.

To discuss the relative value of the armaments of these battle-ships is difficult; yet the gun power is considered, other things being equal, the determining factor of the powers of offence. In fact, a battle-ship should be designed for her armament, for, if this be not properly installed, rapid firing will be impossible. In order to compare thoroughly the fighting value of the armaments of two ships, the following elements would have to be taken into consideration: (1) the various calibers and the weights of the projectiles; (2) the initial velocities; (3) the number of guns constituting the armament; (4) the number of rounds which can be fired by each caliber in a certain time; (5) the field of fire of each gun; (6) the ease with which the different guns can be trained on an object; (7) the accuracy of fire and the chances of useful firing,—conditions which vary in large calibers and in rapid-firing guns; (8) the speed of the ship and her manœuvring powers. Since such comprehensive data cannot be obtained, perhaps the total striking energy of the battery will be sufficient for the purposes of general comparison. In ascertaining this, the batteries should be classified as follows: (1) large-caliber guns, from eight inches upwards; (2) rapid-fire guns, from four inches up to seven; (3) rapid-fire guns of less caliber than four inches, and throwing shot weighing more than one pound.

The value of fire from the different classes of guns varies in other respects than those of tons of striking energy. A rapid-fire gun can easily throw a greater weight of metal in a minute than a large-caliber gun, but it would be misleading to estimate the former at the same value as the latter, for this depends altogether upon the circumstances. So, when instituting the comparison of the battery powers of different ships, the guns of the armament should be classified, and their powers should be reduced to a unit of time. With this method of comparison, it is possible to show approximately the effect of substituting rapid-fire guns for the slower guns of larger caliber, but it should be borne in mind that the smaller gun is not a match for the larger gun when armor is to be pierced. The following table of practical firing-speeds is abstracted from a navy-department publication.

NAME.	Flag.	Displacement. Tons.	Dimensions. Length Feet.	Beam. Feet.	Draft. Feet.	Protection. Belt.	Side.	Turret.	Small Guns.	Deck.	Armament.	Speed Knots.	Normal Coal supply. Tons	I. H. P.	Estimated Cost. Dollars.
Magnificent...	Eng.	14,900	390	75	28	9	9	14	6	4	4 12", 12 6", 16 12 pdr, 12 3 pdr.	17.5	900	12,000	4,561,000
Royal Sov'r'gn	"	14,300	380	75	28	18	4	17	6	3	4 13.5", 10 6", 16 6 pdr, 9 3 pdr.	17.5	900	13,000	4,500,000
Renown.....	"	12,350	380	72	27	8	6	10	6	3	4 10", 10 6", 8 12 pdr, 12 3 pdr.	18	800	12,000	3,500,000
Charlemagne..	French	11,270	385	66	27	16	3	16	3	3	5 4 11.8", 10 5.5", 6 4", 16 3 pdr.	18	680	14,500	5,500,000
Carnot.....	"	12,000	382	70	27	18	4	15	4	3	2 11.8", 2 11", 8 5.5", 4 6 pdr, 16 3 pdr.	17.5	700	15,000	5,400,000
E. Filiberto...	Italian	9,800	345	69	25	10	4	10	10	4	4 10", 8 6", 8 5", 8 6 pdr.	18	600	13,500	
Wörth.....	German	10,000	355	64	24	15		12	3	3	6 11", 6 4", 4 3.5", 8 6 pdr.	18	700	13,000	3,500,000
Preussen.....	"	11,000	377	67	26	12		10		3	4 10", 18 6", 12 3.5", 24 3 pdr.	18	750	13,000	3,530,000
S. Viliky.....	Russian	9,000	341	66	24	16	5	12	5	3	4 12", 6 6", 12 3 pdr.	16	550	9,000	4,000,000
Poltava.....	"	11,000	368	69	26	18	5	10	5	4	4 12", 12 6", 10 3 pdr.	17.5	900	13,000	5,500,000
Indiana	U. S.	10,300	348	69	25	18	5	15	5	4	4 13", 8 8", 4 6", 16 6 pdr.	16	400	9,000	4,500,000
Kearsarge	"	11,500	368	72	26	15	6	17	6	4	4 13", 4 8", 14 5", 16 6 pdr.	16	400	10,000	4,500,000
Proposed.....	"	11,500	368	72	24	16	6	15	6	4	4 13", 14 6", 16 6 pdr.	16	600	10,000	4,500,000



DIAGRAMS SHOWING GRAPHICALLY THE RELATION OF SIZE OF BATTLE-SHIPS NOW BUILDING.

Caliber.	Rate of fire under service conditions.
10 to 14-inch	1 round in 6 minutes.
8-inch	1 " 3 "
6- "	2.5 rounds 1 minute.
5.5- "	5 " " "
5- "	6.5 " " "
4- "	8.5 " " "
12-pounder	10 " " "
6- "	11 " " "
3- "	12 " " "

It is also well to remember that the weight of the projectiles for the guns is different for similar calibers in different countries, and that the initial velocities also vary for the same size of gun and projectile. Therefore, in compiling the subjoined tables, the same elements have been assumed as pertaining to a given type of gun, no matter what the nationality of the piece, for only in this way can anything like a fair comparison be made. As it is, the results are only approximations, but they are fair to all the guns of all the ships concerned.

The first point to strike one in the above table is the preponderating weight of fire per ton of displacement of the new German ship Preussen, and the equally noticeable inferiority of this in the other German ship, the Wörth. This can be accounted for only on the supposition that the information obtainable of the latter's battery is wrong; probably such is the case. The United States ship Kearsarge stands second in the possession of the highest striking energy per ton of displacement; this fine showing is due entirely to the large battery of 5-inch rapid-firers. The proposed new ships of our navy are in the fourth place, and our Indiana class, because of the marked inferiority in the way of rapid-firers, is not above the middle of the list. There is observed, however, the peculiarity of a primary battery composed of two sizes of large guns,—the 13-inch and the 8-inch. In the Kearsarge type there is the same installment. Other nationalities place in their battle-ships, generally speaking, four guns of large caliber, 10, 11, 12, or 13-inch, supplemented by rapid-fire guns of the larger calibers, 4, 5, or 6-inch; then there is a secondary battery of smaller calibered rapid-fire guns, usually known by the weight of their projectiles, as 3, 6, and 12-pounders. These three types we have, as well as the intermediate caliber (8-inch), between the largest breech-loaders and the large rapid-firers. It is because of carrying these guns that our rapid-firers in the Indiana class have to be reduced in number; hence the weight of metal which can be thrown in a minute of time by all the guns of a ship's battery is measurably small.

Before dismissing the subject of the batteries of battle-ships, it should be stated that the tendency outlined in the armaments of the

above ships is to come down from the gigantic guns of 14, 15, and even 16-inch caliber, advocated a few years ago, to guns of 12 and 11-inch; these can pierce the thickest armor, and can be handled by men whenever the machinery ordinarily used for them gives out.

The question of the value of the torpedo is not one requiring much discussion here. No weapon is so little understood; it has never been put to the test, and even in practice its results have in no wise demonstrated its great usefulness. That it is the most powerful engine of destruction is all that can be said of it. In estimating the comparative value of armaments no note has been taken of it.

The matter of armor is next in order. Armor is the defence of the battle-ship. It is, perhaps, sufficient to point out that the efficiency of the defence depends greatly on the arrangement of the armor, and that, until experts can agree upon a comparatively uniform system of distributing the armor, a fair comparison in this respect is impossible. In proof of this, look at the way the armor is distributed on our thirteen typical battle-ships! The very last developments in the way of battle-ships are the Magnificent and the proposed United States ships. On the Magnificent the thickest armor is only nine inches; right beside her in the list is a smaller English ship carrying a maximum thickness of eighteen inches; between these extremes fall the remaining ships under discussion. The manner of distribution is not the same on any two ships,—hence no comparison is possible.

Some of the difficulties in the way of properly deciding which is the best method to adopt in protecting a battle-ship with metal can be understood better by stating in a few words some of the systems followed in armoring the ships given in the table. The Magnificent has a belt of armor of 9 inches' thickness, extending along 216 feet amidships, from about 5 feet below the water-line to as much as 10 feet above it. Thus her whole side, for a portion of her length, is armored. The Royal Sovereign has a partial belt 18 inches thick for a portion of its length; the remainder is diminished gradually to 6 inches at the ends. This belt reaches 4 or 5 feet up from the water-line. Above it comes a side protection of 4 inches. The partial belt of the Renown is but 8 inches; her sides are 6. These examples show the variety existing even in a naval country like Great Britain. France radically differs from every other nation, in that she adheres to a complete water-line belt of armor, from the ram bow all the way to the stern; such a continuous belt is narrower than a partial one, but is quite as thick. In our battle-ships the character of the protection follows more that of the Royal Sovereign class than that of any other type. Generally speaking, the thickest armor on a ship is found on the partial belts and the turrets for the big guns. Some ships carry this same

thickness across the ship in the bulkheads, but ordinarily there is here a slight reduction in thickness. The casemates, or small turrets in which the large rapid-fire guns are emplaced, usually have thinner armor than the large turrets.

All armor in use in the ships now building or to be built is face-hardened steel. Various kinds are being manufactured, the processes differing more or less, but all possessing in common the features of a carburization or cementation of one of the surfaces and a chilling of this face of the plate. In the United States and England the Harvey process is employed to accomplish this; we use nickel steel for armor; England claims that she secures as good results with steel alone; there can be no question that the latter metal is the cheaper. The only point to be observed in the application of armor to modern battle-ships is that greater protection is being given to the battery. The water-line armor of the ships in the Chino-Japanese war was but little injured by shot; but the Chinese could not stand up behind their upper-deck guns, for lack of protection to both crew and gun.

The question of the ability of the different thicknesses of armor to stand punishment is not a difficult one to answer. The gun has always been able to keep ahead of the protection. The heavy guns mounted in the ships we are discussing will pierce the heaviest armor any one of them carries. This, of course, presupposes an attack by the gun on the armor under the most favorable conditions for the gun. What will happen in a fair, square, stand-up fight has yet to be determined. Perhaps then the nine-inch sides of the Magnificent will prove worthy of the name of the ship; perhaps, on the other hand, the long narrow thick belt of the Frenchman will win the day. And, it may be that both these French and British ships will go down when they attempt to stand before the combination of their two methods as exemplified in the distribution of the armor on board the Royal Sovereign or the American ships.

When inspecting the motive powers of the typical battle-ships, much must be allowed for. Horse power under forced draft is an unknown quantity, until the theory of the estimate is put to the practical test. Then, too, it must be remembered that from this estimated horse power is deduced an estimated speed, and this estimated speed will, as like as not, be practically demonstrated to be considerably in error. The facts deducible from the tables of horse power and speed are that there is, on the whole, more unanimity of sentiment on this point than on any other connected with our specimen battle-ships. The object of horse power is to produce speed, and all of the above battle-ships seem to be satisfactorily engined when they can be made to go at about 17 knots. The greatest divergence is only three knots,—be-

tween the 15 demanded of our Indiana and the 18 of the French ship. Actually our ship has, under rather unfavorable circumstances, done better than 15.5 knots; probably the French ship will not come up to the hoped-for 18. Speed in excess—that is, speed acquired at the expense of some other qualification of efficiency—is not a desideratum in a battle-ship. Ships can fight with a good manœuvring speed of 15 knots quite as well as if that speed were 18 knots, for the ships are to fight, not to run away or even think of doing so. Increased speed means the giving up to engine weight that which otherwise could be put into the weight of the battery or of the armor. Unquestionably a certain speed is needed to get to the place of action, and to stay at that place, but, further than this, speed should have no place of prominence.

The data concerning the coal capacity at normal draft and with full bunkers are not complete. So far as can be seen, all battle-ships carry ordinarily but a limited supply of fuel at normal draft, though this amount varies considerably in the different ships. Coal is a good thing to have on board a ship; it is especially good, when the ship is compelled by force of circumstances to wage war in remote seas. But it is on the reserve bunker capacity that these big ships will have to depend when they arrive on the field of battle.

Coast defence is primarily the object with all maritime nations, and this defence is generally to be preserved by winning battles on the open sea remote from the home littoral. Great Britain's line of home defence, however, is to be as near the enemy's coast as she can get; there is where she proposes to establish her first line of fight.

In concluding this discussion of the salient features of some of the latest developments in battle-ships, one finds himself really no wiser than before he began. As an Englishman is distinct from an American, each fancying himself the superior of the other, so is the Magnificent or the Royal Sovereign different from the Indiana or our proposed ships. Until battle-ship meets battle-ship to fight to the death, there will continue to be big ships built by one country, and bigger ones by another; some full of small guns, others with a preponderance of large guns; some covered from head to foot in complete armor, others distributing it about in spots; some will steam at high speed, while others will be content to follow more leisurely; some will stow thousands of tons of coal, others will carry only hundreds. Perhaps all these differences are of no real importance, for the untried factor which, beyond any disagreement, counts most in enabling a battle-ship to perform her duty best is that same factor which won Trafalgar, and which made a naval history for the United States,—"the man behind the gun."

REVIEW OF THE ENGINEERING PRESS

WITH A DESCRIPTIVE INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE AMERICAN AND ENGLISH ENGINEERING AND ARCHITECTURAL JOURNALS.

INTRODUCTORY

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance; (2) to supply a descriptive Index to the leading articles published currently in the engineering, architectural and scientific press of the United States, Great Britain and the British Colonies; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

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American Architect, The *w.* $6. Boston.
Am. Chemical Journal. *b-m.* $4. Baltimore.
American Electrician. *m.* $1. New York.
Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Miller. *m.* $2. Chicago.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Architect, The. *w.* 26*s.* London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $6. New York.
Arena, The *m.* $5. Boston.
Australian Mining Standard. *w.* 30*s.* Sydney.
Bankers' Magazine. *m.* $5. New York.
Bankers' Magazine. *m.* 18*s.* London.
Bankers' Magazine of Australia. *m.* $3. Melbourne.
Board of Trade Journal. *m.* 6*s.* London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick. *m.* $1. Chicago.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
Bulletin Am. Geographical Soc. *q.* $5. New York.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila.
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $3. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan, The *m.* $2. Meadville, Pa.
Clay Record. *s-m.* $1. Chicago.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Compressed Air. *m.* $1. New York.
Contemporary Review. *m.* $4.50. London.
Domestic Engineering. *m.* $2. Chicago.
Electrical Engineer. *w.* 19*s.* 6*d.* London.
Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.
Electrical Plant. *m.* 6*s.* London.

Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Engineer, The. *s-m.* $2. New York.
Engineer, The. *w.* 36*s.* London.
Engineers' Gazette. *m.* 8*s* London.
Engineering. *w.* 36*s.* London.
Engineering Assns. of the South. Nashville.
Engineering and Mining Journal. *w.* $5. N. Y.
Engineering Magazine. *m.* $3. New York.
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7*s.* London.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
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Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6*s.* 6*d.* Birmingham.
Gas World, The. *w.* 13*s.* London.
Gunton's Magazine. *m.* $2. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8*s.* 8*d.* London.
Improvement Bulletin. *w.* $5. Minneapolis.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30*s.* 4*d.* London
Iron & Steel Trades' Journal. *w.* 25*s.* London
Iron Trade Review. *w.* $3. Cleveland.
Journal Am. Chemical Soc. *m.* $5. Easton.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal of Electricity, The *m.* $1. San Francisco.
Journal Franklin Institute. *m.* $5. Phila.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6*s.* London
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Locomotive Engineering. *m.* $2. New York.
Lord's Magazine. *m.* $1. Boston.
Machinery *m.* $1. New York.
Machinery. *m.* 9*s.* London.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7*s.* 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m.* $1. New York.
Mechanical World. *w.* 8*s.* 8*d.* London.
Metal Worker. *w.* $2. New York.
Milling. *m.* $2. Chicago.
Mining and Sci. Press. *w.* $3. San Francisco.
Mining Industry and Review. *w.* $2. Denver
Mining Investor, The. *w.* $4. Colorado Springs.
Mining Journal, The. *w.* £1. 8*s.* London.
Municipal Engineering. *m.* $2. Indianapolis.
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Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6*s.* 6*d.* London.
Popular Science Monthly. *m.* $5. New York.
Power. *m.* $1. New York.
Practical Engineer. *w.* 10*s.* London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Progressive Age. *s-m.* $3. New York.
Progress of the World, The. *m.* $1. N. Y.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
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Sanitary Record. *m.* 10*s.* London.
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Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York.
Scientific Am. Supplement. *w.* $5. New York.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
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Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technograph. *yr.* 50 cts. Urbana, Ill.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn.
Trans. Assn. Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York.
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $3. Butte, Mon.
Western Railway Club, Pro. Chicago.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.

Chief Bonner's Protest Against Tall Buildings.

CHIEF BONNER, of the New York Fire Department, being an able and intelligent official possessing the confidence of the public, his warning of danger to occupants of tall buildings is likely to make an impression. As reported in *Fire and Water* (Sept. 9), the inherent danger, depending upon the height, is likely to be increased, since the over-reaching arrogance of builders seems rather to grow than to diminish; and the chief is reported as saying that he would not be surprised to see buildings five hundred feet high yet erected.

What possibilities of danger to life exist in the case of a fire in one of these structures is best set forth in Chief Bonner's own language, which is of such import that we quote from it liberally. After admitting that the steel frame-work of the modern tall office-building, when the frame-work is properly covered, is practically proof against all the heat that could be generated by the combustion of its wood-work, wooden fixtures, and furniture, and that, in this sense, such buildings may properly be considered fire-proof, he says:

"There is, however, one danger that must be considered. The outbreak of fire in the offices on one floor would naturally result in the combustion reaching other floors. The fire would follow the steam-heating pipes, and spread in that way. Now, smoke is as dangerous to life as flame is, and, suppose a fire in one of the top stories of one of these tall buildings to have gained some headway, one of the most important things to do would be to reach the roof, and open ventilators to let the smoke escape. It would not be so easy to reach the roof of a twenty-five-story structure, with the elevator service cut off by dense smoke above. The elevator shafts themselves would be a source of danger in case of fire, as they would act simply as flues or conductors for smoke. And, as the stairways in mostly all the tall buildings are constructed close to the elevator shafts, and pass by the latter at every landing, it follows that the stairs would become impassable as well as the shafts. Smoke from fire in lower stories would quickly reach the upper ones in this way, and, as elevators and stairs are the only means of escape from those floors that are above the reach of the department's appliances, the peril of the situation is obvious. In my opinion the tall building should have its stairways constructed as far away from the elevator-shafts as possible. There should be two distinct avenues of escape from the building in case of fire. I have said that the term 'fireproof' may fairly apply in the case of buildings occupied only as offices. But, suppose that the constant increase in the number of sky-scrapers causes a diminution in the number of available tenants who want office-room only? This I think is a very possible result, and it will naturally have the effect of filling many rooms in the buildings with tenants engaged in mercantile pursuits. The owners will rent to such tenants as they can secure. Thus there will be quantities of inflammable materials stored within the walls, and an outbreak of fire more probable and vastly more serious. Some of the big buildings have already given up their ground floors to mercantile business, and the tendency in this direction seems to grow. It is entirely different to have a fire break out among merchandise than to have one in an office, with its few desks and chairs. In the former case a degree of heat may be generated sufficient to reach and warp the steel-cage frame and induce a collapse of the building.

"Buildings exceeding 125 feet in height are beyond the reach of the fire department's best efforts. In our opinion 125 feet is the limit of height consistent with safety. If the sky-scrapers are to continue

to soar higher and higher, a law should be passed making it mandatory for the owners to furnish their buildings with first-class machinery for extinguishing fires and to maintain skilled men to operate it. It has been said, and truly enough, that the fire department is paid to protect property from fire. But, as I say, there is a limit to our powers.

"At present there is no law to compel owners of skyscrapers to provide apparatus on their premises. It is only when a modification of the original building plans is applied for that the board of examiners of the building department exacts, as a *quid pro quo*, a stipulation that the building shall be equipped with fire-apparatus. But we do not believe that such stipulations are complied with in the sense in which they are meant, nor can the board of examiners enforce them, as there is no law covering the case. It is merely a question of good faith on the part of the owners. Such appliances as are provided are not, we believe, first-class, nor do they receive any regular care. Besides, they are merely in the charge of the janitor or his staff, who are not trained or skilled in their manipulation. Hence they would prove practically useless in an emergency.

"What the department considers necessary in this connection, in view of the existing and future probable height of 'skyscrapers,' is that a law should be passed containing the following provisions: All present office-buildings, the height of which exceeds 125 feet, should be required to be provided with steam pumps, standpipes, hose, and hose connections. There should be a sufficient pressure of steam up at all hours, day and night, to force the water to the upper floors, and to run at least one elevator car at night. The owners of the building should employ experienced men to work the machinery. These men, who should be continually on duty, would be able to check a fire, pending the arrival of our apparatus. The danger of smoke cutting off the elevator shaft would thus be minimized, and the firemen enabled to ascend quickly to those parts of the building which otherwise would practically be inaccessible.

"The power to insist upon these precautions being observed should be vested in the board of examiners of the building department. The fire department should have in its discretion the approval of the appliances when put in place, and it should also be vested with the right of periodical inspection of them. As long as these precautionary arrangements are lacking in a building above the height I have mentioned, I consider that it constitutes a menace to surrounding property, and that it may justly be regarded in the light of a public nuisance."

The Hennebique System of Cement Arme Construction.

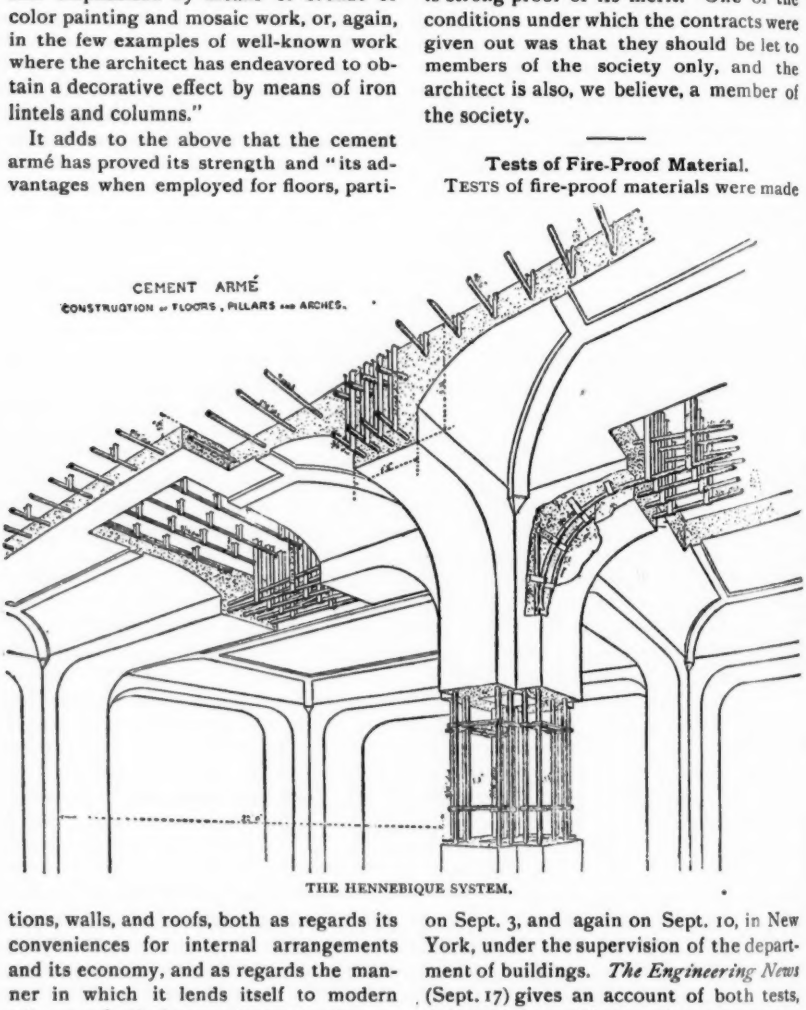
THIS system of construction appears to be meeting with growing favor in France, as a rival to two other prevailing systems of cement armé construction. What is here called cement armé is cement reinforced by imbedded thick wire, trellis, or light bars either of iron or steel. Two of these systems, the Coignet and the Hennebique, are employed in the new building for the Society of Civil Engineers of France, now completed in Rue Blanche in Paris.

In an article on this subject *The Building News* illustrates the Hennebique system, and we herewith reproduce the illustration. Speaking of the use of iron and steel as a building material in France, prior to the present era of cement armé construction, our contemporary says:

"Parisian architects and builders, although far from approving the extremes to which their American *confrères* go in the employment of iron for the construction of their somewhat exaggerated skyscraping buildings, in which the style of architecture employed is often scarcely logical or consistent with the modern methods of construction, are nevertheless obliged to own to the necessity and the utility of employing iron in moderation for the framework of their buildings. Up to the present the use of iron in its ordinary form has chiefly been confined to floors, partitions, and roofs, where, as a rule, its presence is masked by coverings of cement, wood, or stone, except in recent

examples of the new style of buildings destined for *brasseries* or drinking-halls, where the iron construction is left visible, and emphasized by means of bronze or color painting and mosaic work, or, again, in the few examples of well-known work where the architect has endeavored to obtain a decorative effect by means of iron lintels and columns."

It adds to the above that the cement armé has proved its strength and "its advantages when employed for floors, partitions, walls, and roofs, both as regards its conveniences for internal arrangements and its economy, and as regards the manner in which it lends itself to modern schemes of polychrome decoration."



THE HENNEBIQUE SYSTEM.

The illustration of the Hennebique system represents it as employed for floors, pillars, and arches in the building above named. The engraving is self-explanatory. The system has hitherto been used chiefly for "industrial purposes in the north of France," and is said to maintain its ground against the other methods of employing cement armé. Its adoption for the new building for the Society of Civil Engineers is strong proof of its merit. One of the conditions under which the contracts were given out was that they should be let to members of the society only, and the architect is also, we believe, a member of the society.

Tests of Fire-Proof Material.

TESTS of fire-proof materials were made on Sept. 3, and again on Sept. 10, in New York, under the supervision of the department of buildings. *The Engineering News* (Sept. 17) gives an account of both tests, and a summary of their results. The test on Sept. 3 was of the material, cement armé, a variety manufactured by the well-known John A. Roebling's Sons Co., and consisting of "wire netting embedded in cement or concrete, the floors having the netting in the form of an arch between the lower flanges of the floor beams, and sometimes

having a flat ceiling composed of a layer of netting attached to the flanges of the beams and covered with cement and plaster."

"A small steel skeleton building was erected on a vacant lot at Eighty-second street and Western Boulevard, having grates for the floor, and having the roof formed of the Roebling arched and flat-ceiling construction, besides which there were two partitions extending from the walls. The fires were lighted at 11:10 a. m., the temperatures inside the structures being recorded by a Uehling & Steinbart pyrometer and ranged as follows:

	Degrees.		Degrees.
11:26 a. m.	1,150	Noon	1,990
11:30 "	1,300	12:01 p. m.	2,000
11:37 "	1,600	12:02 "	2,025
11:42 "	1,800	12:03 "	2,150
11:53 "	1,800	12:04 "	2,100
11:55 "	1,900	12:05½ "	2,125
11:59 "	1,950	12:07 "	2,150

"About 12:45 a detachment from the fire department extinguished the fire, using a single hose, the principal damage done being the falling of plaster from the wire, leaving the netting exposed, though the concrete above it still carried the load of bricks piled upon it before the commencement of the tests. One partition, with a single sheet of netting, had collapsed, and was nearly stripped of its plaster covering; while the other, with two sheets of netting, though distorted and cracked, was still practically a partition. Some of the ceiling plaster fell from the wire during the fire, and some was knocked off by water from the fire hose.

"In another brick building, ten by eleven feet, with half the roof formed on the Roebling system, the other half being ten-inch hollow tiles all set between ten-inch I-beams, a fire was lighted in the same way, and maintained from about 11:07 a. m. to 12:30 p. m., when it was extinguished by the firemen. On each of the floor-arches was a load of bricks of about nine thousand pounds on a space of four by four feet, but neither arch showed signs of collapse, though some of the netting of the Roebling arch was exposed by the falling off of the plaster."

A subsequent examination by the building department failed to detect any measurable deflection of the iron beams of the floors, which were loaded with one hundred and fifty pounds to the square foot. This test for deflection was made with a level-rod. Some of the partitions had buckled through, not having any chance for expansion. "In one case, where no flat ceiling and air space were used, the wire netting was practically destroyed, but the iron and the concrete are considered amply strong to carry any safe load, so that there would be no need to rebuild the floors because of the destruction of the netting. In the other building the Roebling floor is said to have shown no deflection, while the flat floor showed a deflection of about five-eighths of an inch."

It will be noted that the fire and water tests were about as severe as it is possible to contrive, and that the resistant powers of the material are great.

The test on the tenth of the month was of the system of floor construction of the Fawcett Ventilated Fireproof Company, Ltd., of Philadelphia, which also showed a high resisting power. Both these tests (other tests of a similar kind, it is said, are to follow) will be of interest to engineers and architects, as described in greater detail in the article reviewed.

Effects Obtained by Judicious Painting.

"THE once-despised mineral paint is just now, when properly handled, as dangerous a rival as the elegant carved woods have, even in the most modish and extravagant homes." So says Violette Hall in *The Painter's Magazine*. This writer traces the recognition of the possibilities of mineral paint to the commencement of the "antique craze," when "old rush-bottomed chairs were dragged from the attic, the frames painted a clear, brilliant scarlet, and the seats a dead white, making a gay, pretty effect for piazza seats, or for a simple, particularly a somber, sitting-room, though they were never appropriate when used, as they frequently were, in a stately drawing-room, among more pretentious furniture.

"This bizarre effect of red and white, though not really artistic in itself, has

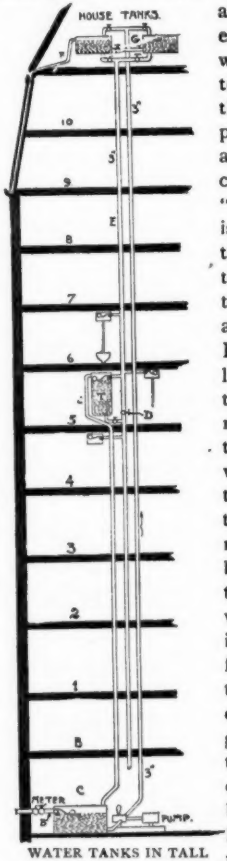
proved useful to the makers of attractive homes, and it disclosed the decorative secrets of mineral paints. Before this era, the impecunious house-furnisher who could not afford the more expensive woods had to resort to the unsatisfactory veneering, or the worse staining, except for the homely bed-room suites known as cottage sets.' These, for some unknown reason, were painted a sort of molasses-candy color, and decorated with bunches of coarse flowers and fruits of the most impossible nature. Later on, these sets took on rather prettier colors, but they were never very ornamental, and have always borne the stamp of rigid economy.

"But, when the clever woman of the family saw how truly pretty the dazzling seat of her red chair was, she very naturally began making other experiments in white paint. She tried it upon her discolored rattan rockers, and also upon certain objectionable stained tables, producing at a small expense really desirable additions to her own and her children's boudoirs. These fresh bits, as a beginning, gradually evolved the snowy-white bed-rooms of present popularity, which now include the painted iron bedstead and the soft wood bureau of quaint design, cheap in the buying, but which, in a coat of white enamel, are pretty enough to satisfy the most esthetic. Nothing could be daintier or more tasteful for the home than this style of furniture, whether it is the lovely Frenchy effects of white and gold of the fashionable drawing-room, or those simpler ones of amateur manufacture which, while less brilliant than the more elaborate affairs of the modish cabinet-makers, make up in a dainty, chaste simplicity something of what they lose in more showy charms."

The use of paint is still further extending. Tea-tables painted a brilliant white, without any other ornamentation, and broad, flat, wooden frames painted a dull silvery green, used for plate-glass mirrors and valuable pictures, are now used in fashionable houses.

Water-Tanks for Tall Buildings.

THE accompanying engraving, reduced from *Domestic Engineering*, illustrates a method of relieving pipes from the undue pressure to which they would be subjected in tall buildings were the water for lower stories drawn from the roof-tanks. Such pipes as are commonly used, or the usual fixtures, would be inadequate to withstand such pressures, and, if extra strong pipes and fixtures were employed, they would very materially increase the cost of the plumbing for such a building. Our cotemporary says:



WATER TANKS IN TALL BUILDINGS.

"The illustration is that of a suppositious building of ten stories and attic, with basement and sub-cellar. House tanks are located in the attic, and an intermediate tank on the fifth floor. It will be observed that the house tanks are connected together by a pipe on which there is a shut-off valve. A three-inch main runs from the pump in the sub-cellar, and divides, a branch going to each tank, with a shut-off valve on each branch. The house supply for the upper five stories is taken from these tanks by a three-inch main, with a shut-off valve from each tank. This main also supplies the tank located on the fifth floor, and there is a shut-off valve at D. The supply of water to the intermediate tank is governed by a ball valve, and there is an outlet from the tank, which is governed by a shut-off valve

There is also an overflow pipe from this intermediate tank, C, which leads into the main receiving-tank in the sub-cellar, so that, in case the ball valve in the intermediate tank fails to work, the overflow will be carried into the receiving-tank, and the water will not be wasted. The overflow from the tanks in the upper part of the house is carried into the eaves. Water is supplied to the main receiving-tank in the sub-cellar through a leader, and its flow is governed by a ball valve."

Furniture of Rooms in Relation with Sanitation.

A SUGGESTIVE article by an unnamed writer is quoted and commented on by the *Plumber and Decorator*. In the article quoted are some points with reference to house sanitation that will be new to many readers. The author does not go to extremes in the reforms he proposes, but at the same time he deprecates the loading of rooms with *bric-à-brac* and furniture, and gives what seem sound reasons for condemning excess in furnishing.

"A room loaded with bric-à-brac and clogged with unnecessary furniture is a distinct and continuous burden. It demands constant care to be kept clean, and its confusion adds to the fatigue of a weary brain. Most of all, such a room is an hourly menace to health. It is impossible to reject longer the statements amply verified by experiments concerning the actions of microbes. We know to a certainty that a million or more of lively organisms may be cultivated into prodigious enemies from an amount of dust taken from the top of a dining-room or sleeping-room door that would cling to the point of a pin."

With reference to the multiplication of disease germs in the small amount of dust which might be lifted on the point of a pin, it may be said that the extreme case is used as an illustration of the danger which may lurk in dust accumulations, and as rendering more emphatic the statement that, the more a room contains, the more difficult it is to maintain a high standard of cleanliness in it.

As to curtains at windows the *Plumber and Decorator* reasonably holds that their action as air-filters in restraining dust from entering rooms compensates for their admitted obstruction to light and air. It might well have added that an apartment kept in a subdued light will be comparatively free from house-flies, which are sore pests to all good house-keepers. On the other hand, a darkened room favors the ravages of moths, so that the *pros* about balance the *cons* on the curtain question. As to carpets all sanitarians are agreed that rugs, which can be conveniently taken up and frequently dusted, are preferable. Immunity from dust is much more difficult to secure in apartments that are over-furnished than where a simple style is adopted. Besides, an apartment over-furnished is a too frequent offence to good taste. A drawing-room is not a museum, yet it is frequently made to look like one. If curios are to be displayed, they should be arranged in a collection in cases in a room set apart. The effect of a beautifully-designed mantel-piece and other architectural adornments is often completely spoiled by a profusion of ill-arranged statuary and bric-à-brac. A few things of this sort, tastefully arranged, may often heighten the effect; but anything placed anywhere for the mere purpose of display is out of place, except in a show-room, and there are many houses whose comfort and appearance would be much improved by relegating superfluous articles to the store-room.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Architecture and Building and Allied Subjects in the American and English Architectural and Engineering Journals—See Introductory.

Construction and Design.

8167. New Engine Houses at Hartford, Conn (Brief illustrated description). Fire & Water–Sept. 12. 500 w.

8369. New Methods of Building Construction at Paris. From *The Building News* (Detailed description of the system employed in the construction of the building for the Society of Civil Engineers of France). Sci Am Sup–Sept. 26. 1600 w.

8454. Difficult Foundations of the Siegel-Cooper Building (Brief description of the new building in New York, with special work neces-

sary on some of the piers on the Sixth Ave. front). Eng Rec–Sept. 26. 600 w.

8472. The Design of Protestant Churches (Most of the matter is derived from the "*Kirchenbau des Protestantis*," a book published under the auspices of the Soc. of Berlin Arch'ts. Traces the influences that have affected the Protestant church architecture). Am Arch–Sept. 26. Serial. 1st part. 3500 w.

*8473. The Proposed War Office (Report of a select committee appointed to inquire into the manner in which the sites available for the erection of the new buildings required for government offices may best be appropriated for that purpose). Arch, Lond–Sept. 18. 3500 w.

*8474. Construction of Stables, Cow-Houses and Piggeries. Louis Hanks (Read before the Sanitary Congress. General rules for arrangement, ventilation, floors and drainage, interior fittings, etc). Arch, Lond–Sept. 18. 2400 w.

*8478. Practical Schools of Brick Design. Robert D. Andrews (Outlines a scheme for establishing training schools where experiments in brick masonry may be tried. Illustrations of fine brick work). Br Build–Sept. 2400 w.

*8479. Architects' Troubles with Brickwork. F. E. Kidder (Discusses the more common troubles met with by architects in trying to obtain first-class work). Br Build–Sept. 2000 w.

*8480. Notes on the Design of Brick Buildings. George F. Newton (The importance of training the imagination, with suggestions helpful to students. Illustrations of fine examples of foreign brickwork). Br Build–Sept. 4000 w.

*8481. What Constitutes a Fire-Proof Building Material. Peter B. Wight (Concludes that a true fire-proofing system can only be based on the use of hollow clay blocks for all interior and roof constructions, and the protection of iron and steel). Br Build–Sept. 1800 w.

†8483. The New Great Northern Theatre and Hotel Building, Chicago (Illustrated description). In Arch–Sept. 4000 w.

*8601. The Architecture of Our Large Provincial Towns (The first of a series of articles which propose to review the architecture of the leading towns of Great Britain, giving illustrations with remarks and criticisms. The present article deals with Liverpool). Builder–Sept. 26. Serial. 1st part. 7000 w.

*8607. Some Optical Refinements in English Mediæval Architecture (The first of a series of articles on the peculiarities in the mediæval architecture of England, tracing in modern architecture also the continuation of standard principles). Arch, Lond–Sept. 25. Serial. 1st part. 2000 w.

8625. The Park Row Building, 30 Stories High: New York City (Illustrated detailed description of the highest building thus far designed in New York city). Eng News–Oct. 8. 3800 w.

Heating and Ventilation

8283. Heating and Ventilating of the Lewis Institute, Chicago, Ill. (Illustrated detailed description). Heat & Ven–Sept. 15. 2200 w.

8284. Heating and Ventilation of the Union Street School Building, Johnstown, Pa. (Illustrated detailed description). Heat & Ven–Sept. 15. 500 w.

8286. A New System of Heating (Illustrated detailed description of a system in which reflection of heat is the underlying principle). Heat & Ven–Sept. 15. 1400 w.

8287. Ventilation of School Buildings (Read before the Am. Inst. of Instruction, Bethlehem, N. H. A general dissertation upon school ventilation, its cost, etc). Heat & Ven–Sept. 15. Serial. 1st part. 3600 w.

8328. A One-Pipe Heating System in a New York Building (Illustrated detailed description of installation in University Building, eleven stories high, and covers an area of 100×177 feet. All floors above the seventh are heated by the one-pipe system). Eng Rec–Sept. 19. 1400 w.

*8446. Warming Auditoriums (Illustrated description of a method whereby, it is claimed, the engineer may control temperature without interfering with the ventilation of an auditorium). Dom Engng–Sept. 900 w.

*8447. A Good Job of Hot-Water Heating (Illustrated description). Dom Engng–Sept. 900 w.

*8448. Heating and Ventilating Residences. James R. Willett (A series of office rules for architects' use in estimating the sizes of furnaces, etc., required to heat buildings). Dom Engng–Sept. Serial. 1st part. 2500 w.

8564. The Mechanical Features of the Siegel-Cooper Department Store (The first part is an illustrated description of the ventilating apparatus in the great Siegel-Cooper store, New York). Eng Rec–Oct. 3. Serial. 1st part. 2000 w.

Landscape Gardening.

8249. The Garden in Autumn (Editorial, and papers from W. Watson, T. D. Hatfield and F. N. Gerard giving suggestions that promise good results). Gar & For–Sept. 16. 4500 w.

8375. A River Parkway (Editorial comment on report recently issued by the Metropolitan Park Commission, and review of the landscape architects, discussing projected improvements in the lower Charles River, in the limits of Greater Boston). Gar & For–Sept. 23. 1300 w.

Plumbing and Gas Fitting.

8280. By-passes of Various Kinds. Grayson (Illustrated description of by-passes that can be used in various situations and for various purposes). San Plumb–Sept. 15. 1200 w.

*8442. The "Lancet" and Sanitary Plumbing (One of the examples of defective sanitary work reported by *The Lancet* (Lond.), and the scheme for remedying defects. Illustrated). Dom Engng–Sept. 2300 w.

*8443. Grease Traps. Reprint from *Home Study* (Illustrated description of a method for intercepting grease and preventing its entrance into drainage pipes). Dom Engng–Sept. 1300 w.

*8444. Fresh Air Inlets (Illustrated description of a number of methods of providing air inlets to running traps on house drains). Dom

Engng-Sept. 400 w.

*8445. A Sample of Criminal Plumbing. C. Desormeaux (An illustrated description of a shamefully botched job). Dom Engng-Sept. 400 w.

8455. Plumbing in Mr. E. C. Benedict's Country House (Illustrated detailed description). Eng Rec-Sept. 26. 1200 w.

8517. The Drainage of Buildings (A paper read before the Sanitary Inspectors' Association, held at Leeds, Eng. A general dissertation setting forth under various heads the essentials to good house drainage). Arch & Build-Oct. 3. 1300 w.

Miscellany.

*8124. An Arraignment of American City Architecture. Ill. E. C. Gardner (Considering the nature and causes of the indifference to art that prevails in city building). Eng Mag-Oct. 3600 w.

*8147. The Strength of Georgia Pine. Harry H. Miles (Experiments investigating the transverse and compressive strength of pine). So Arch-Sept. 1300 w.

*8148. Monument to Jefferson Davis (Brief illustrated description of accepted design). So Arch-Sept. 600 w.

*8162. Kalsomining, or Water Color Painting. A. Ashmun Kelly (Full directions for securing perfect results). Pl & Dec-Sept. 1100 w.

8188. The Revolving Stage at the Munich Royal Residence and Court Theatre (Illustrated description). Am Arch-Sept. 12. 1200 w.

*8202. The Jews as Builders (Claims that the Jews did not distinguish themselves as builders. Buildings mostly of wood. Refers to legends connected with the building of Solomon's temple). Ill Car & Build-Sept. 4. 1000 w.

8270. Tests of Fireproof Material (Describes tests of the Roebling fireproof construction system for floors and partitions of buildings, made in New York on Sept. 3, under the supervision of the Department of Buildings). Eng News-Sept. 17. 1000 w.

*8319. Ecclesiological Notes from North Germany. T. Francis Bumpus (Part first is an illustrated description of the Cathedral in Münster). Arch, Lond-Sept. 11. Serial. 1st part. 3000 w.

*8320. The Action of Heat on Cement. J. S. Dobie (Read before the Engineering Society of the School of Practical Science, Toronto, Canada. The purpose of the paper is to show what may be expected from a mass of concrete or cement, when subjected to great heat). Arch, Lond-Sept. 11. 2400 w.

*8321. Progress in Sanitary Engineering. Andrew Noble (Address delivered before the Section of Engineering and Architecture, of the Congress of the Sanitary Inst., at Newcastle-on-Tyne. General review of progress). Arch, Lond-Sept. 11. 4500 w.

8326. Conditions for Architectural Competition (Editorial comment on suggestions relating to this matter, recently made in the *British Architect*). Eng Rec-Sept. 19. 800 w.

8339. Puy-en-Velay. M. P. Thompson (Extracts from a paper published in the *Catholic World* for Nov., 1882. An interesting account of a visit to this wonderful town, giving some architectural illustrations and descriptions). Am Arch-Sept. 19. 3300 w.

*8340. Revivals in Architecture (Steps which led to the Renaissance in the fifteenth century, and its progress in different countries). Ill Car & Build-Sept. 11. 1500 w.

†8381. Monastic and Lay Craftsmen of the Middle Ages. G. Baldwin Brown (Notes and comments on the late Anton Springer's treatise, "De Artificibus Monachis et Laicis, Medii Aevi"). Jour of Roy Inst of Brit Archts-Aug. 20. 2200 w.

8397. The Duty of Firemen's Associations to Obtain Legislation That Will Secure Better Protection of Life and Property from Destruction by Fire. Christopher Clark (Changes in construction demanded). Fire & Water-Sept. 26. 900 w.

*8416. Damp in Buildings; Its Prevention and Cure. John McIntosh (Calling attention to some of the necessary precautions against damp to be observed in the erection of buildings, and the remedies applicable in dealing with structures in which damp has made its appearance). Ill Car & Build-Sept. 18. Serial. 1st part. 2000 w.

*8482. The Individual Responsibility of the Contractor. D. B. Garnsey (The importance of considering the conditions existing in the community in connection with individual efforts). Br Build-Sept. 1000 w.

*8518. The Premiated Designs for the Edinburgh Street Reconstruction Scheme (Descriptions by the authors of the premiated designs for the reconstruction of North Bridge Street, as given in their reports accompanying the designs). Brit Arch-Sept. 18. 4500 w.

8522. How Can Better Building Inspection be Secured? (Editorial suggested by a recent collapse of a building under construction in New York city. Outlines a plan for the improvement of the character of buildings). Eng News-Oct. 1. 1400 w.

*8608. Man Before Writing. Prof. Flinders Petrie (A lecture delivered in Liverpool. Deals with the earliest expression of the Greek mind, Greek decorative art, pictures of daily life, ornaments and luxuries of life, early architecture, columnar architecture, figurative mnemonics, and high attainments without recorded words). Arch, Lond-Sept. 25. 4000 w.

8633.—$1.50. Transverse Strength of Spruce Beams, and of Norway Pine Beams (Tabulated data obtained in the laboratory of Massachusetts Institute of Technology). Tech Quar-June-Sept. 200 w.

8635.—$1.50. Compression of Timber Across the Grain (Tests made on the 300,000-lb. Emery testing machine at the laboratory of the Massachusetts Institute of Technology, with results). Tech Quar-June-Sept. 250 w.

8642. The Lofty Buildings of New York City (Illustrated review of the changes wrought by this style of architecture, with some reference to the advantages and disadvantages). Sci Am-Oct. 10. 2000 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

The Esthetic Movement in Engineering.

THE ENGINEERING MAGAZINE, both in its leading articles and its editorial columns, has recently offered several contributions to the discussion of the artistic element in engineering-construction; and that the space is well devoted, and the importance of the topic not over-rated, is immediately apparent upon even a casual survey of current tendencies in the field.

The esthetic conception is, indeed, the one new component in our engineering work. It is hardly conceivable that structural materials or forms will undergo more than a moderate modification or adaptation, though these may be as interesting as the suggestions of Mr. J. B. Robinson in this number of this magazine.

Constructional difficulties are fairly well classified and surmountable by well-known means. Gigantic undertakings have become common-place, and do not differ generically from smaller enterprises, or call for more than proportionate enlargement of common methods. Indeed, the triumphant mastery of natural forces extends so far that the impossible hardly exists, except financially. It is the capitalist, not the engineer, who sets the limit of feasibility.

But the introduction of artistic conception as a controlling influence places the engineer on a new plane; and this has been most admirably pointed out by Mr. F. O. Marvin, in his address before the American Association for the Advancement of Science. After sketching the not unnatural absence of such conceptions from our early work, and the coincident feeling that considerations so "impractical" could not be entertained by the engineer without sacrifice of respect, Mr. Marvin says:

"Time was when he was only the tool of some business man who had money to expend in a certain way, and who employed him, under direction, because of some individual ability. But times are changing. In place of the isolated worker, there is growing up a profession with professional standards and an *esprit de corps*, whose members are to be retained, not hired. Cultured, and with the openness and clearness of mind that only come from deep study, broad training, and large experience, these are to be people of influence whose advice and services are sought, leaders whose judgments are respected, and men who can mingle with the best anywhere on a common ground of attainment and character. The very nature of an engineer's qualifications; his technical knowledge; the cultivation of his judicial and critical faculty; his training in fidelity to the trusts reposed in him by private clients,—all these fit him for places of large responsibility concerned with public works, and the people, tired of political management, are beginning to find this out.

"With an engineering practice based solely on immediate results by way of expected profits in dollars and cents the esthetic element has little to do, though even here its absence may mean financial loss. But, from the standpoint of this paper, engineering is to be considered in the broader light of Tredgold's well-known definition, 'the art of directing the great sources of power in nature for the use and convenience of man,' while the engineer is he who designs and executes engineering works.

"The engineer is primarily a designer. He works with the materials of nature as his medium, and her powers as his tools wherewith to express his thought. . . . Just as in the making of a picture the brushes, paint, and canvas are not the chief things, so here it is not the wood, steel, and brass, or the powers of gravity, steam, air, and electricity, that are most important, but rather the character and quality of the design, and the degree of realization in its execution.

"In a certain sense, then, every engineer

is an artist, and in some directions at least, as in architecture and other forms of construction and in the making of public parks, the result of his cultured brain may attain to the dignity of a work of 'fine art.' Perhaps, in its true essence, there may be as much fine art in the design of a machine to produce bolts as there is in the making of a picture for the Salon; certainly the well-planned tool, with fine proportions and parts perfectly related, is above the poor canvas.

"From the vantage-ground of his position as a man of educated intelligence and trained ability, the engineer owes the world his best effort. It needs and asks for technical skill and scientific knowledge whereby to-day's work may be done. But also, without knowing exactly what it wants, it feels the need of those added qualities it cannot define, and seeks for guidance and help to something better for to-morrow. In the long run, it will honor the man that meets the demand, and will measure his efficiency on more grounds than that of dollars and cents.

"To the superficial or hasty thinker there may appear a conflict here between the utilitarian and the artistic, but there can be no real antagonism. The result of any act of designing is to be judged as a whole and in the light of all the purposes to be fulfilled. The physical conditions imposed by the materials used and the forces of nature employed are to be met. These conditions must be expressed in the design frankly and candidly, and in such a way as to indicate clearly its purpose, and to gratify the observer through its proportions, symmetry, harmony, and decoration. The end desired must be attained in the most direct and simple way, so that the expenditure of money may be a minimum. These are the three elements of design,—the scientific, the esthetic, and the financial.

"The current engineering practice gives great attention to the first and last of these elements, and but little comparatively to the second. There is no branch of it but would be benefited by adding to scientific and business ability a knowledge of the principles of artistic design, and an impulse to give expression to it. The effect on the life of our communities and the nation by such a change is not easily estimated.

"We are not an esthetic nation, but we have latent possibilities in that direction; we are young, confident, and impressionable, and have the courage to be original in design, which counts for much. We have evolved the American locomotive, the American truss bridge, the American automatic machine, the American much-debated tall building, and many other things specially adapted to American needs. We shall grasp the artistic possibilities of construction quickly when we come to know what they are, and shall apply them confidently, not always at first with the most happy results. We shall learn some things from the old world, and shall assimilate much that is good in its practice, but in the end engineering here will be both artistic and American."

Extending the principle to machine construction, Mr. Marvin quotes appreciatively from Mr. Albert Williams's article in THE ENGINEERING MAGAZINE for October, 1895. He sketches the indications of the influence, sometimes faultily interpreted, in municipal, railroad, and bridge work; and, coinciding with Mr. Gardner, another ENGINEERING MAGAZINE contributor, he says, regarding bridges particularly: "It is not so much a matter of adding ornament as the proper treatment of the organic lines, the length of spans, the relation of length of panel to height of truss, the location of the piers, and the form of their outlines. Ornamentation is not to be used so much for its own sake, but rather where it is needed to accentuate these organic markings."

Mr. Marvin applies the principle broadly, even to the laying-out of our cities; recognizing freely the obstacles to improvement which are fixed by financial necessities and established topography, he yet thinks something can be done toward "mitigating the present evils and avoiding any repetition of these in the future. Radical treatment must be resorted to by way of diagonal avenues from congested centers, and the widening-out of the intersec-

tions of important streets into parks and plazas. There must likewise be an heroic struggle with the water-fronts and internal watercourses, places full of picturesque possibilities, though usually given over to filth and ugliness. These changes are made imperative, not only by esthetic requirements, but also by the demands of health and business."

This conclusion is strong with hopefulness. He "firmly believes that there is a latent esthetic quality in American life that is now struggling to find both means for its gratification and methods of expression. Before there can be knowledge of its meaning and power, there must be many attempts and many failures. The whole process is one of education, and that largely in the school of experience. This applies to the industrial and constructive arts, as well as to the fine arts. The engineer will share in the general movement, but this is not enough. As a designer of so much that the world needs for daily use, he must do more than keep up, he must keep in advance.

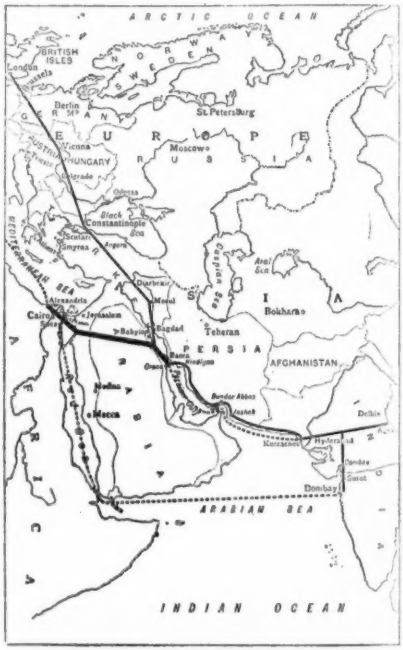
"Yet it should be emphasized that the desired change is not, after all, so far ahead of us. To some extent at least the coming engineer has already arrived, and is making himself felt. The leaven is at work."

An Engineering Project in the East.

THE scheme for "an Egypto-Assyrian Railway as the new overland route to India," sketched by Col. A. T. Fraser in the *Journal of the Society of Arts*, while primarily relating to a piece of railway construction, is too broad in its scope to be classed merely as a railroad item. The development of the project would necessarily involve important bridge, dock, and harbor works; but, beyond that, it would be a factor in Eurasian politics scarcely, if at all, inferior in importance to the Suez canal.

It was so strongly impressed upon Col. Fraser at the time of a "visit to the Persian gulf and Mesopotamia during three months' leave" that he prepared a paper addressed to the Royal Geographical Society; but he was anticipated by Mr. Black's "exhaustive article, 'The Railway to India,'" in the *Contemporary Review*.

Both Mr. Black and Col. Fraser emphasize the point that "the Arabian overland route is . . . an entirely new idea." Heretofore the proposal has always been to extend the line eastward from Alexandretta to Biredjik, at the head of Euphrates navigation, and follow the Euphrates valley thence to the Persian gulf. Alexandretta, however, is infested with malaria, and deeply involved in international complications. The second objection applies with still greater force (from Col. Fraser's point of view) to the very direct rail route which



ROUTE OF PROPOSED EGYPTO-ASSYRIAN RAILWAY.

would be established by throwing a huge bridge across the Bosphorus at Constantinople and prolonging the rails south-eastward across Asia Minor, although this would be the most direct line, and would extend an unbroken railroad system from the English channel to the Persian gulf. Furthermore, "owing to the insistence by the Porte that railroad concessions can only be given to Turkish subjects, great delay is occurring in Syrian lines, while the time-honored necessity of *bakshish*—or

greasing of official palms—comes in awkwardly at every step on Turkish soil by which real progress is effected. A Calais-Kurrachee through-train is, after all, a superfluity to a power like Great Britain, with a maritime trade and sea command.

"Laying a railway between Ismailia and the head of the Persian gulf would at once alter the whole complexion of affairs, at a cost of some £5,000,000 sterling, because the steamers already trading to India can do all the remainder of the work. The new overland route could be opened for mails, passengers, and the relief of European troops at the running through of the first Arabian train from Egypt.

"Nor are there any special engineering difficulties to encounter. From Ismailia, after crossing the Suez canal by either a subway or a swing-bridge, there would be a plunge into the winding valleys and sublime desolation of the desert of Sinai; and then the line would make for the head of the Gulf of Akaba, for convenience of access and protection by the British flotilla in the Indian seas. The only at all heavy engineering operations would be in crossing the deep valley above Akaba, which is a continuation of that of the Jordan, and getting upon the tableland of Arabia. Once on that elevation, there is nothing to be expected but the stony desert ring, which Palgrave speaks of, and monotonous undulations of a gravelled surface, with the hollow pass of the Jowf midway, all the rest of the distance down to Bussorah.

"The route across Arabia is consequently the most favorable possible for a railway, crosses an insignificant amount of drainage, and is remarkably clear of settled inhabitants.

"The point to be aimed for in Mesopotamia, as the junction with the Assyrian line from Constantinople is of importance, will, for topographical reasons, be somewhere near Bussorah, where the combined Euphrates and Tigris—known as the Shatt el Arab (or Arab river)— is narrow, and where a bridge must be placed when the line is carried round along the coast of Persia and Beluchistan to Kurrachee. This junction will be so important because it is through it that the supply of coal for the new route, its railways, and its steamers will most likely be derived."

"Branch lines of railway . . . would bring down the trade of southern Persia to its old center at the straits of Ormuz, connecting the port of Bunder-Abbas with Bagdad, *via* Shiraz and Ispahan, and giving Indian travellers a cool alternative route.

"But, returning to the main subject, in order to start the new overland route without any delay, it is necessary to carry the line eighty miles south of Bussorah to the deep-water anchorage of the port of Koweit, and clear of the muddy bar at the mouth of the Shatt el Arab, which is at present impracticable for large steamers. The new route will then have Alexandria at one end and Koweit at the other extremity.

"As fast vessels can make the run down the Persian gulf from Koweit to Kurrachee in less than three days, and it will not take more than a day to cross Arabia by rail, there is an enormous lessening of the time—and, therefore, cost of transit—between the Mediterranean and India. It will only take four days where it now takes ten. The reduction is all the more striking reckoned from Bussorah, whose mails will reach Egypt in one day, that now require nineteen days to get there."

The extremely important political bearings of the project are suggested by Col. Fraser's reference to the "urgent problems demanding solution connected with our temporary occupation of Egypt on the one hand, and the Indian empire, with its nascent home-rule aspirations, on the other. These would be at least greatly simplified if the distance between India and the Mediterranean were reduced to a quick and cheap five days' journey.

"The effect, politically, of the simple and comparatively inexpensive measure of connecting Ismailia and Koweit by railway is nothing short of transferring the commercial frontier of the Indian empire at one sweep from Sind to Alexandria, for it is apparent that only at Alexandria can the harbor facilities, combined with adequate

protection, be got for the vast Indian trade the railway would bring. What arrests the frontier on the borders of Sind is, seemingly, the strip 1,000 miles long of stony deserts, to be had almost for the asking, and very nearly ready for the plate-layer to commence his operations."

It is significant that, though the occupation of Egypt is referred to as "temporary," the very basis of the scheme implies the continuous control of Ismailia. And it is but a few days since the foreign dispatches mentioned the khedive's *incognito* visit to France, with the supposed intention of moving toward the termination of British control over Egypt.

In the great game of European politics, statesmanship and engineering enterprise are curiously intertwined.

Tendencies in Engineering Education.

PRESIDENT MERRIMAN'S address before the Society for the Promotion of Engineering Education, delivered at Buffalo last August, has been widely copied and commented upon, and attracts as wide attention in the English engineering papers as it did in the press on this side.

His conclusion summarizes admirably the best modern conceptions of the scope and tendency of a properly-organized course. It supports so strongly certain positions recently taken in these columns that we give Prof. Merriman's last sentences, as follows:

"After four years of work the engineering student receives his degree, and is ready to commence the actual work of life. What the letters are that designate the degree is a matter of small importance. Moreover, if we examine the lists of the alumni who graduated ten or fifteen years ago, the conviction arises that their particular course of engineering study has not been an absolute factor in determining their actual line of engineering work. It is found that graduates in civil engineering are engaged in mining, in machinery, and in electricity, and that graduates in other courses are employed upon work in which they received no especial technical instructions.

"Looking now over the field of tendency thus briefly outlined, it is seen that there has been ever present a powerful impulse towards specialization, to which, indeed, nearly all others have been subordinated. This has demanded a higher standard of admission, great thoroughness in all fundamental subjects, and a rigid adherence to scientific methods. Engineering education has had an active and healthy growth. It now enjoys the respect and confidence of the public, and its future is sure to be more influential than its past. It is not specialization that has caused its success, but rather the methods which specialization has demanded. Those methods have resulted in imparting to students zeal and fidelity, a love of hard work, of veneration for the truths of science, and a consciousness of being able to attack and overcome difficulties; these elements of character are, indeed, the foundation of success in life.

"Looking now forward into the future, it is seen that, in our efforts for the promotion of engineering education, a wide field for work still lies open. The student should enter the engineering college with a broader training and a more mature judgment. The present methods of instruction are to be rendered more thorough and more scientific. In particular, the fundamental subjects of mathematics, physics, and mechanics are to be given a wider scope, while the languages and the humanities are to be so taught as to furnish that broad, general culture needed by every educated man. In general, let it be kept in mind that education is more important than engineering, for the number of men who can follow the active practice of the profession will always be limited. Hence, let it be the object of engineering education to influence the world in those elements of character that the true engineer possesses, so that every graduate may enter upon the duties of life with a spirit of zeal and integrity, with a firm reliance upon scientific laws and methods, and with a courage to do his work so as best to conduce to the highest welfare of his race and his country."

The point to be emphasized and reiter-

ated—so often is it overlooked by hasty students and myopic critics—is that the process of specialization is not one of paring down, but of concentration: it is not one of cutting off all collateral streams, but of gathering them into a single channel.

The student impatient of studies which seem to him indirectly related to his main theme, who discards the broader work for a "special course," as a rule makes a fatal mistake. The special course should be a sequence of the general one; it can never be a substitute for it.

The Failure of Columns Under Eccentric Load.

THE engineering department of the Yorkshire College, Leeds, according to *Engineering*, has been making some interesting tests with a hundred-ton Beckton machine. The one which appears to have the widest importance was of a hollow cast-iron column eleven inches in diameter, one and one-eighth inches thick, and ten feet in length.

Of course a column of such size, centrally loaded, could not be tested to destruction by compression, except by a power at least ten times greater than the maximum limit of this machine; the pressure in the college tests, however, was not applied centrally, but on one edge of a very heavy bracket cast with the column. The piece has, in fact, a massive double-bracketed head, as if designed to stand under a line of floor-beams and receive the ends of beams from both sides; and the load was applied "in exactly the manner in which it was intended to load similar columns in practice," seventeen inches from the center of the column (neglecting the slight deflection due to loading).

Under this application the column failed at 65.5 tons. The break started on the side opposite to that on which the pressure was applied and about a foot below the bracket, in the straight portion of the column. It extended through in an oblique upward direction to the loaded side, just below the fillet at the base of the bracket.

Test-pieces were afterwards cut from the lower part, and showed a tensile strength of 8.45 tons per square inch, and a compressive strength of 30.4 tons per square inch.

The sectional area of the column at the point of fracture was 34.3 square inches, which would give a total compressive strength of over 1,040 tons,—about sixteen times that at which it was actually completely ruptured.

It is at once evident that the column failed, not by compression, but by tension on the side opposite the load, due to bending.

Prof. Goodman is engaged on a series of tests of centrally- and eccentrically-loaded columns, and also of columns with concentric and eccentric cores, but is not yet ready to announce more than the suggestion of results.

In some of these investigations he places special extensometers, reading to $\frac{1}{10000}$ of an inch, on four sides of the column under test. As the eccentric load is first applied, all four show about equal compression; but, as the column bends, the instrument on the convex side indicates diminishing compression, and, ultimately, tension, while that on the concave side shows rapidly-increasing compression.

The results obtained on the single column whose fracture is described indicate, says *Engineering*, "the utter folly of loading columns in this manner,—a practice which, unfortunately, is far too common among architects."

TRANSPORT says: "The Commission which has been inquiring into the proposal to unite New York and Philadelphia by means of a ship canal, has issued its report, and a very valuable and interesting document it is. Two surveys were made under the direction of the commission. By either route vessels would use the Delaware river from Philadelphia to Bordentown. Thence a canal would be cut across New Jersey, entering the sea at Sandy Hook. The distance between the two cities would thus be reduced from 274 miles to 92 miles, of which 31½ miles would represent the canal.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

8173. Erection of a Long Four-Track Drawbridge (Explains some of the striking featurs of the erection of the trusses and special appliances used in the construction of the bridge over the Harlem River. Illustrations). Eng Rec–Sept. 12. 1500 w.

8268. Hinged Concrete Bridge Across the Danube. O. J. Marstrand (Abstracted from "*Zeitschrift fuer Bauwesen.*" Describes a bridge connecting the village of Inzigkofen with the opposite side of the Danube. The greatest economy was necessary, and the conditions somewhat unusual. Illustrated). Eng News–Sept 17. 1100 w.

*8309. Notes on Weigh-Bridges. Oscar John Kirby (The two varieties of this class of bridge are explained, and the difficulties that are met with, and means of overcoming them are given). Eng, Lond–Sept. 11. 1800 w.

8368. The Rigid Suspension Bridge at Loschwitz, Saxony. Robert Grimshaw (Bridge over the Elbe, just above Dresden, is described and illustrated. The principal innovations introduced are named and described). Sci Am–Sept. 26. 3300 w.

8374. The New East River Bridge (An illustrated account of the new bridge to be built from near the foot of Broadway, Brooklyn, to a point near the foot of Grand St., New York). Ir Age–Sept. 24. 3500 w.

8378.—$1. Suspension Bridges—A Study. George S. Morison (The paper is submitted with a view to opening the way for improvement and to show that a great suspension bridge, which would be well adapted to railroad service, would involve no insurmountable difficulties of construction. A suspension bridge of unusual dimensions and capacity is illustrated and the design explained). Am Soc of Civ Engs–Sept. 16500 w.

8419. The New St. Lawrence Bridge at Montreal (An account of a bridge to be built for railway, street railway and highway traffic, by the Montreal Bridge Co). Eng News–Sept. 24. 800 w.

8423. Diamond Drill Borings for the New East River Bridge Pier Foundations (A description of the plan of work adopted to determine the depth of bed-rock, preliminary to founding the towers of the new East River bridge). Eng News–Sept. 24. 700 w.

*8565. Construction in Earthquake Countries. C. A. W. Pownall (An article intended to supplement a late contribution of John Milne, in further explanation of the destruction of the bridge over the Nagara River in Japan). Engng –Sept. 25. 2000 w.

Canals, Rivers and Harbors.

*8549. The Conditions Necessary for Equality of Velocity in Particles Settling Through Liquids. Luther Wagoner (The object of the discussion is to examine the facts about grains under one millimeter size. Abstract of published results of Prof. Richards are given). Jour of Assn of Engng Soc–Aug. 900 w.

Irrigation.

8269. The Pecos Valley Irrigation System. L. B. Howell (Describes a system having at present 200,000 acres under its operated canals. Gives map, cross-section of lower dam and views). Eng News–Sept. 17. 1500 w.

Miscellany.

8138. Proposed Standard Specifications for Portland Cement (Letters to the editor from S. B. Newberry and Robert W. Lesley, with reply from William J. Donaldson). Eng News–Sept. 10. 900w.

†8205. "A New Method for Determining the Supporting Power of Piles." Franz Kreuter (Explains a new method which the author considers simple and reliable). Ind & East Eng–Aug. 22. 1200 w.

*8288. The Engineering Department of the Yorkshire College, Leeds). Experiments made in the laboratory are described and illustrated. They include tests of cast iron columns, wire rope, hooks, eye-bars, aluminum, and brick arches). Engng-Sept. 11. 2400 w.

†8354. British Highways (Extract from a report prepared by the chief engineering inspector of the local government board). Cons Rept–Sept. 9500 w.

†8356. Manufacture of Portland Cement in Belgium (An account of this extensive and important industry. Ordinary lime, best hydraulic lime, slow setting cement (Portland), and quick setting cement (Roman), are especial products of these immense quarries). Cons Rept–Sept. 3000 w.

8379.—$1. Experiments on the Protection of Steel and Aluminum Exposed to Sea Water. A. H. Sabin (Results of tests on plates with various preservative coatings). Am Soc of Civ Engs–Sept. 3000 w.

8425. Mr. Donaldson's Proposed Standard Specification for Portland Cement. Robert W. Lesley (A letter to the editor in reply to letter of W. J. Donaldson, showing that the latter had incorrectly quoted from a previous communication). Eng News–Sept. 24. 2500 w.

8452. Tests of Sands for Making Mortars (Abstract of a paper by M. R. Feret, chief of the "Laboratorie de Ponts et Chaussées" at Boulogne, prepared from the translation by O. M. Carter and E. A. Geiseler). Eng Rec–Sept. 26. 1500 w.

8521. Trestle for Carrying a Flume at Saltville, Va. Emile Low (Description, with illustrated details, of trestle designed for a special purpose). Eng News–Oct. 1. 900 w.

We supply copies of these articles. See introductory.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Architecture.

Troubles of Electricians at Sea.

As landsmen always like to read about life at sea, they will find a very entertaining as well as instructive sketch of the troubles encountered by electricians on sea-going vessels in *The Electrical Engineer* (London, Sept. 11), in a paper contributed by Mr. E. Craig-Brown. These troubles appear to be wholly unknown to the average central-station electrician on land, or in isolated land plants, whether complicated or otherwise; they arise from causes inherent in the conditions on sea-going vessels, which are widely different from those on land. It is true that the dynamos at sea take their energy from the ship's boilers, but, as Mr. Craig-Brown says, the electrician "must take his steam as he gets it,—*i. e.*, as made for the main engines." And there are, in some instances, breaks in the supply of power to the dynamos, and irregularities, so that it appears to be a fact that a kid-glove engineer from a finely-installed central station "would find himself at sea in more than one sense, if suddenly asked to run the electric-lighting plant of one of our large ocean-going steamers." An example of what he might encounter is set forth in the following quotation:

"*Scene*, engine room of deep-sea steamer; *time*, say, 10.30 P. M. All going sweetly, main engines running well, engineers in good humor. Electric department satisfactory, voltage good, electrician also in good humor. *Group*, consisting of the engineer on watch, the boiler-maker, and the electrician, spinning yarns under the lamp near the starting-gear. Ghost-like 'paneewallahs' flitting about with oilcans and handfuls of waste amongst the plunging rods and levers overhead. Suddenly, in middle of boiler-maker's best story, 'Cri-i-i-n-n-n-n-n-n-g!!' goes the telegraph, 'stop.' 'Cri-i-i-n-n-n-n-n-n-g!' again, 'half astern.' A second's pause; then the boiler-maker is running up the ladder with a spanner to stand by that troublesome reversing gear on the h.-p. eccentrics; the engineer is unlocking the levers, and the electrician is replying to the bridge by the telegraph. That done, he rushes to his machines. The 'fourth' has pulled over the levers, and is hanging on to one of them; the little starting engine has begun to work, spitting, knocking, and sticking. A little help to 'the wheel' by hand, and it is flying round, the oil coming off its rim tangentially and going on to the faces of the electrician's friction pulleys. The main engines slow down, and the extra steam thus left in the boilers sends up the pressure. The dynamos whirr, up goes the voltage till the lamps look like melting, and at the same time up goes the electrician's hand to the regulating valve. Too late; what with the sudden increase of speed and the oil from the starting-wheel, the friction is overcome and the pulleys slip. Down go the lights, up goes the smell of burning oil and resin, and the dynamo-engine races as if it would knock itself in pieces. In vain does the electrician apply his best pocket-handkerchief to the pulley faces; the initial friction having been overcome, nothing short of slowing down and the judicious application of powdered chalk to their faces will cause the pulleys to 'grip' again.

"By this time the cause of the sudden stoppage becomes known. [Run into a Chinese fishing fleet off Fu-chow-fu, or something of that sort.] The telegraph signals 'slow a-head,' and the chief engineer is anxious to know 'What's wrang wi' they ——— machines again, as the captain has been speerin' at him aboot the lichts?'

"To continue, 'Does the dynamo not supply the leads with current?' 'Well, yes, in a way. The positive lead gets all that doesn't leak from the brush rocker into the hull of the ship.' You see (unless our

electrician is lucky, and has one of these slow-speed drum armatures to manage),the motion of the ship has to overcome a very considerable amount of gyrostatic action in the armature. The bearings, therefore, are subjected to heavy work, and, if they are lined with white metal, he gets rather anxious about them on a rough night,—so anxious that, sooner than see them running out at the end of the spindle from overheating, he is lavish with the oil. As their temperature still increases, however, he borrows some snow from the refrigerator man, and applies it to the outside of the plummer blocks. It *may* keep the bearings from getting too hot, but it certainly *does* run everywhere when it melts, even over his vulcanite washers, and leakage follows, as a matter of course. Speaking of rough nights, if he is not used to them, he may have occasion to go on deck several times 'to see if there is much phosphorescence in the sea.' During his absence the machines are left more or less to themselves, as the engineer on watch may not be conversant with dynamos."

The three systems of leads in use in marine practice are "(1) the double, (2) single, and (3) concentric. The double leads are on the same principle as those on shore,— *i. e.*, one positive and one negative." Advantages and disadvantages of each system are set forth clearly in a subsequent part of the paper; prefaced by the following remarks:

"The single system is the oldest, as it is the one that would naturally occur to a telegraph electrician. The negative wire is put to 'earth' on the nearest bulkhead. This is better than merely taking the insulating washer out of the negative brush-holder. Similarly, the return wires from each lamp have to go to 'earth.' This, of course, entails much drilling and tapping of ⅜-in. holes in plates for terminal screws.

"The concentric system is used chiefly in the royal navy, and, where expense is not the chief consideration, it is undoubtedly the best. Jointing requires a trifle more skill and patience than in other systems. Making a joint ashore is one thing; at sea, quite another. Picture the electrician trying to stand on a camp-stool in a cramped and dark corner of an alleyway, with a rapidly-cooling solder-bolt in one hand, and a stick of solder in the other. The ship is pitching and rolling; so he has to steady himself by pressing his head against the ceiling. Temperature say ninety-something, and vision imperfect, owing to excessive and continual perspiration. The most angelic temper sometimes gives way in such circumstances."

The double system of leads requires less tapping of plates, has fewer sources of short-circuit and leakage, is less likely to affect the ship's compass, and reduces to a minimum the danger of shock to passengers. On the other hand, it requires more drilling of plates and costs more to install; its chances of rupture, by straining of the ship, and of corrosion, are greater than with the other systems; more time and trouble are exacted in repairs; it occupies more space on account of the double casing, necessitates double cut-out fuses, and is not impervious to dampness.

The single system is simple and cheap to install, and needs only a single-casing; its repairs are simple, and its faults easily located; and it requires fewer and simpler cut-out fuses. *Per contra*, it requires tapping for earths, there is danger of shock from faulty and damp switches, there are chances of short-circuit and leakage along the leads, ship's compasses are liable to be affected by it, and, like the double leads, it is not impervious to dampness.

The concentric system requires casing only where there is a chance of rough usage; it is economical of space, and less unsightly than other systems; it reduces to a minimum the liability of short circuits and leakages, is less likely to affect the compass, possesses the least liability of shock, and is impervious to damp. Its first cost is greater, it requires greater skill for repairs, and it is liable to damage by indentation.

Other interesting points are dealt with, but this review must close here with the remark that Mr. Brown has written one of the best practical papers of the month.

Damage to Underground Pipes by Electrolysis.

IT is probably true that nearly all evils are accompanied by some good, and that all that helps mankind to desirable ends is attended with some evil as part of a price paid for progress. The application of electricity to street railroads is an instance in point. If a popular vote could be taken, there would be found an overwhelming majority against a return to previous methods of moving street-cars, notwithstanding the loss of life and injury to persons chargeable to the system, and the fact that it has entailed trouble and danger to municipalities through electrolytic action upon underground water- and gas-mains. These evils being admitted, the question of retaining a great good, with well-directed attempts towards mitigating the attendant evils, would be decided affirmatively by the great majority of intelligent people.

Popular attention has been much directed to the accounts of death and mutilation by the trolley service, of which the sensational daily press has made the most it could. Few have stopped to think that, in proportion to the number of people transported, the accidents resulting from this mode of transportation are less in number than those resulting from riding in carriages drawn by horses; yet it may confidently be asserted that such is the fact, and that travel by trolley is safer than travel by horses and carriages. Those who have studied the subject believe that, as time goes on, the proportion of casualties to the number of those who ride in trolley cars will become less, till a minimum is reached.

So much for the danger above ground. Below the surface another evil has been at work, and forcing itself upon the public attention. This is set forth in a summary made from a pamphlet issued by the electrical bureau of the National Board of Fire Underwriters, and printed in *Progressive Age* (Oct. 1).

"Underground water-mains have broken down because of faults unquestionably due to electrolytic action, and smaller service-pipes have been weakened to such an extent as to break at critical moments, when excess pressure is put upon them at intervals during a fire. Measurements show that conditions unquestionably exist in nearly every district in the United States covered by a trolley road, which are favorable for destructive action on the subterranean metal work in the vicinity; and pipes taken up in many of these districts show unmistakable signs of harmful effects. The general nature of this action and the causes which bring it about are too often seen to need elaborate description. Briefly, it may be compared to the action which takes place in an electro-plating bath. The current which enters the bath through the nickel or silver metal suspended therein, flowing through the bath and out through the object to be plated, ultimately brings about the destruction of the suspended piece of metal. Similarly, the current from a grounded trolley system, flowing through the earth in its course from the cars back to the generating-station, selects the path of least resistance, which is generally for a whole or part of the way the underground water-mains, and, at points where it leaves the pipes to reach the station, the iron of the pipe wastes away, until at points the walls become too thin to withstand the pressure of the water, and a break-down ensues. The difference of potential necessary to bring about this action is very small,—a fraction of a volt,—and consequently, in all districts where potential differences are found between water-pipes and the surrounding earth, such actions can be assumed to be taking place, for dampness and the salts necessary to produce electrolysis are present in all common soils.

"Whenever, then, a reading is shown by an ordinary portable volt meter registering tenths of a volt, with the positive binding post in electrical connection with a water-pipe or hydrant and the negative binding post in electrical connection with an adjacent lamp-post, car-track, or metal rod driven in the earth, electrolytic action will be found, upon examination, to be taking place at that point, which will ultimately result in the destruction of the water-pipe. The only certain remedies for this

evil are obviously to keep the current from using the pipes as a conductor, or keep it from flowing through the pipes to the surrounding soil. The first remedy necessitates a complete metallic circuit for the railway, and the second a joining of pipes by wires wherever potential differences are found. Trolley roads having absolutely no ground-connections will not be installed as long as the present trend of practice prevails, and consequently an absolute complete metallic circuit for such roads cannot be secured. Bonding all underground pipes together with wires of sufficient carrying capacity to prevent current-flow through the earth would also be obviously impossible. By judicious employment of part of each remedy, however, it has been demonstrated that the evil can be so largely reduced as to be practically negligible, and it is to securing these improvements in the numerous trolley districts of the country that the energies of every one interested should be devoted."

Here we have the evil, the method by which it may be locally detected, and its cure, all clearly stated. We have also the information that the existence of this action upon pipes is not exceptional, but that in nearly all instances where the trolley system has been installed pipes are suffering injury. Why, then, is the known remedy not vigorously applied? There is scarcely any class of investments that yields a better return than the trolley street railroads. They can well afford, and should be compelled, to prevent all preventable damage from the operation of their lines. The public danger lurks, not in the inherent tendency of the lines to induce electrolysis of underground pipes, but in the inherent weakness and corruption of municipal government, that obstruct the enforcement of the duties and obligations which the street-railway corporations owe to the public.

Insurance of Electrical Plants.

THE fire hazard of electrical plants is a topic of interest to all in any way concerned in the use or management of electricity for generating light or transmitting power. In its relations to fire insurance, the subject was brought before the North Western Electrical Association in a paper by Mr. R. H. Pierce (*American Gas Light Journal*, Sept. 21). A statement of the results of a central-station fire is made, among them being the loss of insurance when it can be proved that the rules and requirements of the National Board of Fire Underwriters have not been observed. In such a case there will be added to the loss by interruption of service the loss of the plant. An intimation is made that strict examination would reveal the fact that some existing plants are not insurable, and that, where this is the case, the central-station manager is answerable for the defects. Mr. Pierce says:

"A large proportion of existing plants were installed at a time when the electrical manufacturers and electrical constructors did not understand what materials and methods should be used in order to secure safety; and finally, and worst of all, many plants have been installed by companies or individuals whose only thought was to get the largest price for the cheapest installation, leaving the unfortunate station owners and managers to wrestle with the question of safety, as well as of reliability and economy. But, however serious the question may be, it must be met, and, if attacked in the right way, the solution may not be as difficult as it at first appears."

For the safety and reliability of central-station property proper "care, protection, and attendance" are needed. The rules of the National Board of Fire Underwriters are approved as a guide to the needed appliances and constructions for safety.

The author decidedly favors insurance in responsible companies rather than formation of mutual companies for central-station owners; of the latter he says:

"The plan of forming a central-station owners' mutual company has been 'weighed in the balance and found wanting.' Theoretically, it may be possible to form such a company, but it would be an additional burden to the central-station

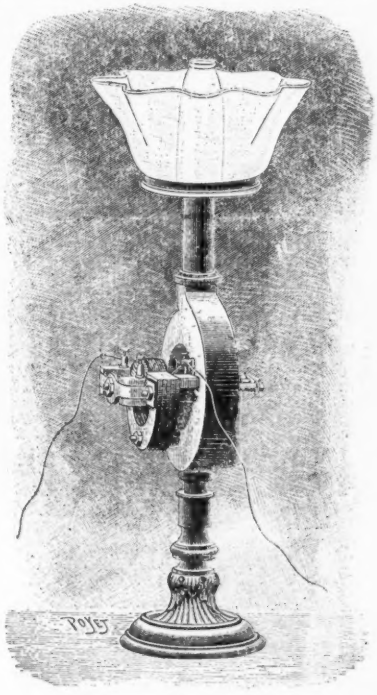
business, which, I take it, has trouble and problems enough to face already. If fire insurance is a legitimate business,—and it appears to be as legitimate a business as electric lighting,—then we may as well assume that the insurance people know their business, and that the competition between insurance companies will produce as low a rate as could (with equal protection) be given by a mutual company."

There exists a third plan,—"securing maximum safety and then taking the chances." Mr. Pierce thinks that in very special cases only is this the best plan. "If the central-station plant is so designed, installed, and operated as to reduce the fire hazard to a minimum, insurance companies will ask a minimum rate of insurance, which, in most cases, will be so small as to be no burden to the owners. Discarding, then, the two plans just mentioned, we are brought to the first plan of insurance in reliable companies. Accepting this as our line of action, the problem now is to so install and operate our plants that the hazard is reduced to a minimum, or at least to a point where further improvements would increase the cost out of proportion to the additional safety secured. . . . Competition in the electrical manufacturing and construction business has not led to increased safety. On the contrary, it has led to cheapness in both appliances and methods, and cheapness does not mean safety. On the other hand, we must not think that we must be extravagant in order to have safety. The use of proper methods of construction and of intelligence and care in operation is what is most necessary to secure safety."

Of the thirty-four causes enumerated by the underwriters which may, when all exist, raise the premium to over ten dollars per hundred, the following are named as representing more than half the amount,—to wit, improper arrangement of stack, defective wiring, improper construction of switchboard, improper construction and placing of rheostats, storage of oils, gasoline, etc., in station, and improper storage of ashes. One or more of these faults exist in many central stations.

The Denayrouse Lamp.

THE Welsbach incandescent gas-lamp has proved a formidable competitor to electric lighting, and the question of the final commercial triumph between gas and electricity for illumination has much occupied the space of papers devoted respectively to the interests of gas and electric industries. The answer seems perhaps likely to be somewhat further deferred by the advent of the lamp herewith illustrated and described, in which the use of mechanical draft in connection with gas and an incandescent mantle has produced results which are, to say the least, astonishing, if reports about them are to be trusted. The description is condensed and the engravings reproduced from *L'Illustration*, a translation of whose article is reprinted in *Scientific American Supplement* (Sept. 26).

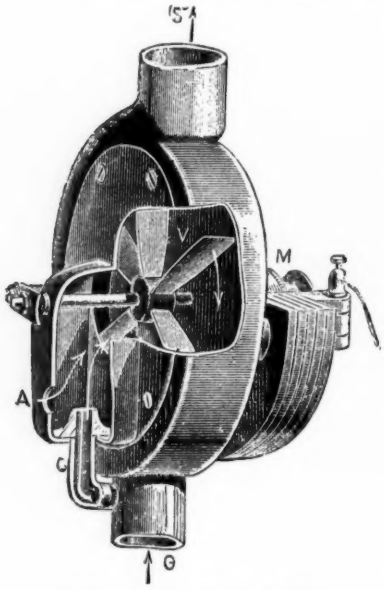


THE DENAYROUSE LAMP.

This lamp causes the gas to burn in four and four-tenths its volume of air, five and

five-tenths its volume being the theoretical quantity stated as necessary to such combustion of illuminating gas as will give it its highest illuminating power when burned in air. It is scarcely necessary to say that the theoretical proportion is not nearly maintained, either with the ordinary open gas-burners or generally with the argand burner.

The engravings are (*a*) a view of the Denayrouse lamp as it appears in operation, and (*b*) a sectional view of the mechanical draft appliance, in which the



SECTION OF THE LAMP.

entrance for air is shown at A, and the entrance for gas at G, and in which V represents the mixer and M the electric motor.

"The apparatus consists essentially of a bronze or brass box in which revolves a fan keyed upon an axle that passes through the box. The axle is revolved by means of a small electro-magnetic machine mounted upon one of the external sides of the box. The motor may also be a hydraulic or compressed-air one. Upon the axle is arranged a speed-regulator. The air enters at the bottom of the box and the gas at the center. The exit of the mixture takes place through a chimney arranged at the top and to which is fixed a luminous mantle. The apparatus operates as follows: The motor causes the fan to make about 1,200 revolutions a minute. There is thus formed a strong draught of air, which mixes with the gas that enters at the side. The ignition occurs at the upper aperture of the chimney."

Such is the simple description of a very simple arrangement. A comparison of cost makes the cost of the Denayrouse light only half a centime per carcel-hour more than that of the ordinary butterfly gas-burner.

The intensity of its light adapts it particularly to the illumination of public places,—parks, gardens, squares, etc.,—and disqualifies it for ordinary interior lighting. The requirement of a motor for each lamp will also add another disqualification for its general use in interior lighting. Exterior illumination appears to be the field for the new invention, if it can be called new. Lamps supplied with air by clock-work motors were invented years ago, and the mere substitution of one kind of motor for another can hardly be called a new invention. The combination of parts with the previously-invented mantel, whose incandescence intensifies the illumination, may possibly form the basis of a valid claim; but even this seems doubtful.

The intensity of the light seems to adapt it in many situations for light-houses. Should it prove that no royalty can be exacted under patents for the use of this lamp, it is likely to come into a somewhat extended use for special purposes to which it is adapted.

Electricity in the United States.

IN a serial paper contributed to *The Electrical Engineer* (commencing Sept. 23), Lieutenant B. A. Fiske, U. S. N., starts out with a statement, taken from the journal named, that careful investigation shows the capital invested in the various electrical arts to be no less than $1,500,000,000. This sum almost staggers belief, but it is probably no overestimate. Its

very magnitude indicates the enormous extent to which electricity now lends its aid to the other natural forces previously brought under human control. One can scarcely enter an industrial establishment of any importance, a public building, or a private residence having any pretence of comfort or luxury, without meeting with familiar or unfamiliar electrical appliances. A peculiar feature of this pervasiveness is the extent to which electricity has been made to contest the field with mechanical appliances. This is alluded to in a review of Lieutenant Fiske's paper in our department of Marine Engineering; but this contest is not confined to marine appliances; it is actively waged on land. One of the battles apparently won by electricity is its successful application to the transmission of power in machine-shops and manufacturing establishments. Belts and shafting have been replaced by it in many large works, and its use for this purpose is steadily growing in favor. In our opinion compressed air, though it has found a place which it will probably hold among methods of power transmission, can never be made so universally serviceable and practicable as electricity for this purpose. But the contest is extending to other mechanical constructions. Motions that once required ingenious and complicated mechanical movements are now effected by the simple magnetization and demagnetization of electro-magnets. Hand-worked machines have moulted their hand-cranks, and small electric motors have been substituted. Clutches whose operation formerly required a lever and clutch-fork are now made to engage by the pressure of a button, or the movement of a minute switch. Electric regulation of clocks, of throttle-valves, and of many other appliances is now common. It is impossible to see where all this will stop. Probably electricity will continue to invade fields wherein mechanical construction has hitherto been wholly relied upon, and other mechanical movements will, in their turn, be supplanted.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical and Engineering Journals—See Introductory.

Lighting.

8146. Electricity at Neuchatel, Switzerland (Illustrated description of plant). W Elec–Sept. 12. 1800 w.

*8186. Connecting Incandescence Lamps in Series on Alternating Currents. E. B. in *L'Industrie Electrique* (A study of incandescence lamps, their connection in series on reaction coils and on little individual transformers). Elec Rev, Lond–Sept. 4. Serial. 1st part. 1300 w.

†8210. The Electric Lighting of Calcutta: Messrs. Kilburn and Co.'s Project (Discusses unfavorably the proposed low-tension scheme of Messrs. Kilburn and Co). Ind Engng–Aug. 15. 2000 w.

8257. Care and Management of Electric Motor-Meters. Thomas Duncan (Remarks and hints on their management, calling attention to the requirements necessary for the successful installing of meters). Am Elect'n–Sept. 3500 w.

8329. Dr. H. Lux on the Lighting of Berlin (Review of a book which presents an excellent survey of the present position of gas manufacture, and of the supply of electrical energy throughout Germany). Am Gas Lgt Jour–Sept. 21. 1700 w.

8330. Test of an Isolated Electric Lighting Plant. S. A. Beyland, in the *Scientific Magazine* of the Univ. of Tenn. (The results of tests of the gas-engine and lighting plant belonging to the First Methodist Episcopal Church of Knoxville, Tenn). Am Gas Lgt Jour–Sept. 21. 600 w.

*8336. Notes on Electric Light in Sea-Going Vessels. E. Craig-Brown (The great difference between practices on sea and land. The difficulties and disadvantages of certain systems). Elec Eng, Lond–Sept. 11. 2200 w.

*8337. Proposed Scheme for Electric Lighting of Aberdeen Harbor (Abstract of report as published in the *Aberdeen Journal*. Description with estimate of cost). Elec Eng, Lond–Sept. 11. 800 w.

*8338. Installations with Incandescence Lamps at High Voltage (Discusses whether it is preferable to use lamps of 100 volts with an efficiency of 2½ watts per candle-power, or lamps which absorb 4 watts with a tension of 220 volts). Elec Rev, Lond–Sept. 11. 1200 w.

8386. Electrical Energy at Toulouse (Illustrated description of system). W Elec–Sept. 26. 1200 w.

*8413. The Lighting of the Great Eastern Railway Company's Stations (Illustrated description of system adopted). Elec Rev, Lond–Sept. 18. 500 w.

8502. Electric Lighting in Nemotown.

We supply copies of these articles. See introductory.

Harry N. Gardner (Brief description). Elec Eng–Sept. 30. 2500 w.

8503. The Spectrum of Reflection and the Efficient Illumination of Confined Space. Dr. W. H. Birchmore (A study of spectra to determine why our lamps seem to make darkness visible rather than the objects in it). Elec Eng–Sept. 30. Serial. 1st part. 2500 w.

†8587. A New System of Series Arc Lighting. Thomas Spencer (An illustrated description of a system devised by Mr. William Smith Horry, called his "Reactive System" of arc lighting). Jour Fr Inst–Oct. 1500 w.

*8602. Electric Glow Lamp Tests. William Henry Preece (Experiments to determine an expeditious and reliable way of testing the efficiency and durability of glow lamps. Supplement of curves referred to, and full description. Read before the Brit. Assn. for the Advancement of Science). Elec Rev, Lond–Sept. 25. 2000 w.

*8605. Street-Lighting by Electric Incandescent Lamps. William George Walker (Read before the British Assn. Remarks on this subject with examples where they have worked satisfactorily). Elec Eng, Lond–Sept. 25. 1800 w.

8620. The Design of Large Arc Dynamos. George Albers (Describes a complex commutator as an accompaniment to a type of machine which is given as an example of the extreme practical limit of subdivision of units for a large station). Elec Eng–Oct. 7. 2200 w.

8626. The Cheapest Electric Lighting Plant in the World (Illustrated description of the plant in Johnson, Vt., a village of only about 600 inhabitants. Figures of cost and full particulars are given). Eng News–Oct 8. 4500 w.

8628. Fashions in Arc Lamps and Supports (Illustrations of numerous designs and methods of suspending lamps, that have been in vogue at different periods and in different places, with brief descriptions). W Elec–Oct 10. 800 w.

Power.

*8125. Gas versus Electricity for Power Transmission. Nelson W. Perry (Analyzing the disadvantages that attend local transmission by electricity). Serial. 1st part. Eng Mag–Oct. 4900 w.

8132. Memoranda on Tests of a 300 H. P. De Laval Steam Turbine (Test at 12th St. Station of Edison Illuminating Company of New York. Tabulated statement, with editorial). Elec–Sept. 9. 2000 w.

8133. Ventilating Electrical Subways (Editorial presenting the difficulties of the problem and suggesting the substitution of exhaust for forced draught). Elec–Sept. 9. 700 w.

8134. On Rotary Currents with Reduced Speed. Hans Gorges (Paper read before the Verbandes Deutscher Elektrotechniker, Berlin. Translated from *Elektrotechnische Zeitschrift*. Phenomenon described and attention called to the more important points of the investigation). Elec–Sept. 9. 1000 w.

8141. Electrical Equipment of the New England Building in Cleveland (Brief illustrated description). Elec Wld–Sept. 12. 800 w.

*8171. The Folsom-Sacramento Electric Power Transmission Plant (Brief description, with illustration of the 24-pole three-phase machines). Eng, Lond–Sept. 4. 900 w.

8208. The Big Creek Power Transmission (Illustrated description). Jour of Elec–July. 1200 w.

8211. The Electrically Driven Mills of the Pelzer Manufacturing Co., Pelzer, N. C. (Illustrated description with the advantages incident to the driving by electricity). Elec Eng–Sept. 16. 1600 w.

8212. Extension of the Niagara Power House. Orrin E. Dunlap (Views and drawings illustrate the scene of the wheel-pit and power house extension, and make clear the changes to be made). Elec Eng–Sept. 16. 1100 w.

8258. Commutator Brushes for Dynamo-Electric Machines; Their Selection, Their Proper Contact Area and Their Best Tension. Alfred E. Wiener (Complete consideration from the practical standpoint of the subjects treated. Gives formulas by means of which the cross-sections of brushes and commutator pressure may be simply calculated for any given condition, the results being expressed in square inches and pounds). Am Elect'n–Sept. 2500 w.

8259. Speed Regulation of Induction Motors. P. M. Heldt (The writer shows that the speed of such motors may be varied through wide limits. A number of methods are described for producing variation of speed). Am Elect'n–Sept. 1500 w.

*8323. Electrical Works in Switzerland—The Val de Travers Station. J. E. Petavel (Illustrated description). Elect'n–Sept. 11. 800 w.

8331. Experiments with a Differential Wattmeter. A. B. Reynders, in the *Scientific Magazine*, of the Univ. of Tenn. The making of a differential wattmeter is described and the method of using it). Am Gas Lgt Jour–Sept. 21. 1200 w.

8362. Series Reversing Motor and the Switch and Wiring Connections Used Therewith. William Baxter, Jr. (Explains the series type of motor, and the operation of the switch). Am Mach –Sept. 24. 1700 w.

8363. Additional Tests of Power Absorbed by Electrically-driven Machine Tools at the Baldwin Locomotive Works (Tests made by C. W. Pike, including three-spindle drilling machine, two-spindle drilling machine, radial drilling machine, vertical boring and turning mill, lathe, planers, slotting machine, double-head locomotive frame-slotting machine, double-head frame-slotting machine, and shaping machine). Am Mach–Sept. 24. 1000 w.

8388. Measurement of Power in Two and Three Phase Circuits by Means of Wattmeters. Dugald C. Jackson (A résumé of the various ways in which wattmeters may be applied to the measurement of the power in polyphase circuits). Elec Wld–Sept. 26. 1300 w.

*8412. Electricity Down a Coal Mine (Illustrated description of the method of coal haulage in the Abercanaid colliery, Merthyr Tydvil, Wales). Elec Rev, Lond–Sept. 18. 1400 w.

8499. Shunt-Wound Reversing Motor, and the Switch and Wiring Connections Used Therewith. William Baxter, Jr. (Changes in the reversing switch from the one used in the series machine. Explanation and diagram). Am Mach –Oct. 1. 1000 w.

8524. The Water Power and Electric Transmission Plant of the Big Cottonwood Power Co. W. P. Hardesty (Illustrated detailed description). Eng News–Oct. 1. 4800 w.

8534. German and French Accumulators (Illustrated description of two special forms of accumulators that are attracting attention abroad —The Boese and the "shuttle"). W Elec–Oct. 3. 1200 w.

8539. Electrical Apparatus of the Fort Wayne Electric Corporation (Illustrated description). Elec Wld–Oct. 3. 4000 w.

8551. A Few Pointers for Purchasers of Electric Machinery. William Baxter, Jr. (Discusses the most important points that determine the merits of a machine). Power–Oct. 2500 w.

8562. New Weave Shed and a Two-Phase Electric-Power System for the Grosvenordale Mills (Illustrated description of a weave shed which is a departure from the ordinary practice, and of the additional electric power installed). Eng Rec–Oct. 3. 1000 w.

*8606. Notes on Electric Cranes. E. W. Anderson (Read before the British Assn. Experience that the writer has had with electric cranes in practical use in the Erith Iron works. Considers the system the very best method that has yet been devised). Elec Eng, Lond–Sept. 25. 5000 w.

8621. Present Status of the Distribution and Transmission of Electrical Energy. Dr. Louis Duncan (The writer purposes to take up the different methods of transmission and distribution and to consider the limits that are actually fixed by the present status of electrical development. Part first deals with generating plants and electrical distribution. Presidential inaugural address read before the Am. Inst. of Elec. Engs. Abstract). Elec Eng–Oct. 7. Serial. 1st part. 3000 w.

8641. Electrical Tests of Power Required by Metal-Working Machinery at the Navy Yard, Washington, D. C. O. G. Dodge (Tests of vertical boring machines and planing machines). Am Mach–Oct. 8. 900 w.

8647. Electrical Machinery of the Walker Company (Illustrated description). Elec Wld–Oct. 10. 2000 w.

Telephony and Telegraphy.

8142. An Arrangement for Counting the Conversations of Telephone Subscribers. Jul. H. West (A brief description of a device by which a conversation is counted to the two subscribers using the instruments and the cost divided between them). Elec Wld–Sept. 12. 700 w.

*8187. International Telegraph Conference at Buda Pesth. Translated from the *Journal Télégraphique*. An account of the work done during six plenary meetings). Elec Rev, Lond–Sept. 4. Serial. 1st part. 1800 w.

8209. Thermostatic Fire Alarm Telegraphs. George Herbert Stockbridge (The reliability of the service rendered by this automatic system since recent improvements). Jour of Elec–July. 3000 w.

8315. The Telephone in Railway Operation (An illustrated description of the telephone as used by the extensive system of the Metropolitan West Side Elevated Railway Co., of Chicago). W Elec–Sept. 19. 1800 w.

*8324. The Telegraph in the Ashanti Expedition (1895-6). (Particulars culled from official sources, with regard to the construction, maintenance and method of working of the telegraph during the recent Ashanti Expedition). Elect'n–Sept. 11. 1800 w.

8384. The Telephotic Problem.—A Proposed Solution. Dr. Ernst Huber (An addition to the study of sending light vibrations over a wire. In the method described the Röntgen ray is introduced as an auxiliary at the receiving end). Elec Eng–Sept. 23. 1500 w.

*8504. A Telegraph Cable Attacked by White Ants. E. L. Bouvier, in the *Comptes Rendus* (Account of a cable from Haiphong (Cochin China) which had been eaten away by these insects). Elect'n–Sept. 18. 750 w.

8535. Ingenious Cable Codes. From the *N. Y. Tribune* (Some of the difficulties met with in the use of codes, and information regarding them). W Elec–Oct. 3. 1000 w.

*8604. Electrical Disturbances in Submarine Cables. W. H. Preece (Read before the British Assn. A study of the causes of disturbance and a discussion of the best form of cable). Elec Eng, Lond–Sept. 25. 2500 w.

8614. Improvement in Dynamo-Telegraphy. F. P. Medina (Illustrated description of plant installed by the Pacific Postal Telegraph Co., in San Francisco). Jour of Elec–Aug. 2300 w.

8615. Submarine Telephone Work in New York Bay (Brief account of the recent connection of quarantine islands with the mainland, with map showing route taken). Elec Rev–Oct. 7. 500 w.

8616. History of the Telegraph in Belgium. V. B. (Brief account of the progress of the telegraph in this country, which has just celebrated the 50th anniversary of its introduction). Elec Rev–Oct. 7. 600 w.

Miscellany.

*8130. The Possible and the Impossible in Electric Development. Wm. Baxter, Jr. (Showing how much and how little it is reasonable to expect from electricity as a source of light, heat, and power). Eng Mag–Oct. 2800 w.

8139. On the Seat of Electro-dynamic Force in Ironclad Armatures. William Baxter, Jr. (Objections to conclusions reached by Messrs. Houston and Kennelly). Elec Wld–Sept. 12. 1200 w.

8140. Magnetic Units (Complete report, presented by Prof. Hospitalier before the Geneva Electrical Congress). Elec Wld–Sept. 12. 1600 w.

8145. Manufacture of Potash by Electrolysis.

Orrin E. Dunlap (Illustrated description of process and plant at Niagara Falls). W Elec-Sept. 12. 1500 w.

*8184. The Magnetization and Hysteresis of Certain Kinds of Iron and Steel. H. Du Bois and E. Taylor Jones (Results of investigations, with explanation of process for the construction of permanent magnets). Elect'n-Sept. 4. 2800 w.

*8185. The Part Played by the Dielectric in the Discharge of Röntgen Rays. Jean Perrin (From the *Comptes Rendus*. Describes experiment which justifies conclusions stated). Elect'n-Sept. 4. 800 w.

8239. An Induction Coil. J. B. Hall (The construction of an induction coil to give a 4-in. spark, to be used for producing X rays with vacuum tubes). Can Eng-Sept. 900 w.

8256. Electrolytic Copper and Silver Refining (An illustrated description of the electrical generating plant of the Guggenheim Smelting Co., at Perth Amboy, N. J., and of the electrolytic process). Am Elect'n-Sept. 1800 w.

8264. Mutual Induction of Parallel Distributing Circuits. Dugald C. Jackson (A contribution to the several treatments on the calculation of the inductance of transmission lines). Elec Wld-Sept. 19. 900 w.

8265. Electrical Waves in Long Parallel Wires. A. D. Cole (Abstract of paper read before A. A. A. S., Buffalo meeting. Facts described were brought out in experimental study undertaken as a preliminary to a research on the refractive index of certain liquids for electrical undulations as deduced from a measurement of the ratio of the wave-length in the material under investigation to that in air). Elec Wld-Sept. 19. 2200 w.

8275. An Arrangement of Resistance Boxes. A. O. Benecke (Diagrams with explanation of improved arrangement). Elec-Sept. 16. 300 w.

*8325. Some Distinctive Features of Continental Electrical Engineering Practice. Kenelm Edgcumbe and E. J. Fox (Read at students' meeting of the Inst. of Elec. Engs. Points out in what respects Continental practice in general may be said to differ from that in England, with a few of the advantages and disadvantages met with in the respective systems). Elect'n-Sept. 11. 5800 w.

8332. The Insurance of Electrical Plants. R. H. Pierce (Extract from paper read before the Northwestern Electrical Assn. The problem of safety the real question). Am Gas Lgt Jour-Sept. 21. 1000 w.

*8333. Applied Electro-Chemistry. James Swinburne (Points touched upon in the first of four Canton Lectures on this subject). Jour of Soc of Arts-Sept. 11. 4400 w.

†8348. Effect of Temperature on Insulating Materials. George F. Sever, A. Monell and C. L. Perry (Conclusions drawn from results of 102 tests on samples of materials. Discussion and communications). Trans Am Inst of Elec Engs-June & July. 6000 w.

†8349. An Experimental Study of Electro-Motive Forces Induced on Breaking a Circuit. F. J. A. McKittrick, with an introduction by Dr. Edward L. Nichols (Illustrated description of method employed, also a variety of methods for the recording of current curves. Brief discussion follows). Trans Am Inst of Elec Engs-June & July. 5000 w.

8359. Tesla's Electrical Condenser (The inventor's own description, with sectional view). Elec Rev-Sept. 23. 800 w.

8390. Electrolysis and Some Problems in Molecular Physics. C. L. Mees (Abstract of an address before the Physics Section, American Assn. for the Advancement of Science. The first part reviews the progress in the study of electrolysis). Elec Wld-Sept. 26. Serial. 1st part. 2000 w.

†8403. The Velocity of Electric Waves. Clarence A. Saunders (Investigation based on the phenomena of resonance. Historical review of past attempts, with description of method and apparatus used in this investigation, with results). Phys Rev-Sept.-Oct. 6000 w.

†8404. Admittance and Impedance Loci. Frederick Bedell (Read before the Physical Society of London. A study of the relations and principles). Phys Rev-Sept.-Oct. 1500 w.

†8405. Visible Electric Waves. B. E. Moore (Describes apparatus and method used by author in showing electric waves to a class. The method is serviceable for lecture purposes). Phys Rev-Sept.-Oct. 1200 w.

8491. Tesla's Electrical Oscillators (Illustrated description of Mr. Tesla's perfected transformers or oscillators The description is largely the exact language of the inventor). Elec Rev-Sept. 30. 2400 w.

8492. A Gas Battery Experiment. J. R. Payson, Jr. (Experiments with sulphuretted hydrogen in endeavoring to develop electrical energy direct from fuel. The writer thinks it presents features that may render it valuable). Elec Rev-Sept. 30. 1800 w.

8501. Protection Against Lightning for High Potential Power Transmission Circuits. A. J. Wurtz (Diagrams illustrating system of protection with explanation). Elec Eng-Sept. 30. 500 w.

*8505. On the Magnetic Behavior of Electrolytic Iron, Nickel and Cobalt. W. Leick (Abstract from *Wied. Ann.* Investigations of the magnetic behavior of iron deposits, giving their susceptibility and intensity of magnetization in absolute measure). Elect'n-Sept. 18. 3500 w.

†8542. On a New Method for Reading Deflections of Galvanometers. C. B. Rice (Describes a method recently devised by Prof. C. S. Hastings). Am Jour of Sci-Oct. 1200 w.

8619. The Electric Fountain in Willow Grove Park, Philadelphia. H. S. K. (Illustrated description). Elec Eng-Oct. 7. 800 w.

8630.—$1.50. Notes on the Best Form of Cross Section for the Coils of a Galvanometer. Frank A. Laws (Experimental determination of the curves bounding the best form of cross section for two cases are given, when the needle is indefinitely short). Tech Quar-June-Sept. 700 w.

INDUSTRIAL SOCIOLOGY

Economic Effect of Appreciating Money.

THE first article in *Gunton's Magazine* for October is an attack upon the long-held and widely-accepted economic theory of bimetallists that (according to Mr. Balfour, who stated it in an address before the English Bimetallic League as "a great principle in national finance") "an appreciating currency is disastrous to the business of a nation." That this proposition has been accepted by many men—some of them of high reputation as economists—does not prove it to be true. Time and again has error been widely accepted as truth, and many economic theories that once commanded widespread approbation have been abandoned.

The effort of the author of the article reviewed is to prove the falsity of the proposition as stated by Mr. Balfour, at least in its application to the social status of the world at the present day. He begins this task by calling attention to the great change that has come over the nations of the world. Before the development of manufacturing industries, "national prosperity centered in the middle and upper classes, because they represented the great consuming power in the community for manufactured and artistic products; in fact, for everything which made for progress in the arts, sciences, literature, architecture, sanitation, education, domestic appointments, and all the higher phases of civilization. The laboring classes were consumers of little else than food-stuffs." The growth of the factory system has made essential "a broader social foundation, which the daily consumption of wealth by the laboring classes only could supply."

With this preliminary consideration of changed conditions are coupled the propositions: (*a*) "The basis of social welfare in all ages, and under all conditions, is the demand or market for products;" (*b*) "If the consumption of any particular class represents the controlling element of demand or consumption, the prosperity of that class constitutes the prosperity of the nation, because it furnishes the economic influence that sets in operation the forces which make the production and distribution of wealth profitably possible. Whatever fills that function in the economy of society constitutes the view-point from which the public welfare must be considered, and public policy conducted."

It is then argued that, as seventy per cent. of the population of the United States are wage- and salary-earners, these occupy the basic position, and that upon their welfare the prosperity of the country depends. Implicitly this is held to be true for every nation in which a majority of the people are wage- and salary-earners.

"They occupy this controlling position, not because they are superior in quality, but because, being more numerous, their consumption determines the market for all lines of commodities produced for sale. When we realize that the home consumption of the American people is equivalent to ninety-four per cent. of the entire products of the nation, the economic importance to national prosperity of the consuming power of three-quarters of the population is obvious. No elaborate reasoning is necessary to show that whatever affects the prosperity and consuming power of this three-quarters practically controls the prosperity of the nation. Consequently, the social condition and consuming power of the wage and salary class constitute the economic view-point of national prosperity, because the success of all lines of industry in which modern methods are employed depends upon the market sustained by their consumption. Point-lace, diamonds, and a few lines of art products may be sustained by the consumption of the profit-receiving class, or even by the few very rich, but industries in which large capital is required to produce best results, such as railroads, telegraphs, ocean transportation, and the nu-

merous lines of manufacture, can be profitably sustained only through the consumption of their products by the millions."

If the argument, so far, be accepted as sound, it logically follows that the truth or falsity of Mr. Balfour's proposition depends upon whether an appreciating currency affects adversely or otherwise the welfare of wage- and salary-earners. And, though a certain policy may temporarily benefit "the payers of interest or the drawers of profits, . . . if it tends directly or indirectly to lessen the income and consuming power of this wage class, . . . it necessarily undermines the very source from which profits and interest can be paid." Therefore, rising wages or falling prices, either of these increasing "the purchasing power of a day's work," are maintained to be indications of increasing prosperity to a nation.

"The period of unparalleled progress and prosperity of which this country boasts is distinguished for both these economic movements. During the twenty-five years previous to 1893 wages rose and prices fell; so that laborers receive more dollars for a week's work, and more wealth for a dollar. In this absolute increase of wealth and welfare for a day's work consists the real progress of the nation.

"From whence does this increase of wealth to the wage class come? It is not a gratuitous gift from the capitalists and wealthy classes; it is the laborers' share in the new and constantly-increasing increment of wealth created by the economic forces of civilization. In other words, it is a transfer of a part of the profits resulting from the application of science and capital to enterprise. In reality the only progress the world ever makes is in the creation of new increments of wealth in some form of surplus, as interest, rent, or profits. These are the avenues through which all the increase of human welfare comes into existence. The distribution of this constantly-augmenting fund of new wealth to the masses constitutes the equities and industrial ethics of civilization."

The arbitrary Socialistic methods of restricting profits, confiscating rents, regulating rates of interest, or proscribing the size of large fortunes are condemned as "uneconomic and wasteful," and as impracticable, "because their enforcement operates directly to check the creation of the very fund which it is designed to distribute." It is admitted that the general complaint that the distribution of wealth is not now rapid enough has a foundation, but improvement is possible only through "economic and social influences which tend silently and constantly to disperse this increasing fund of new wealth."

"The laborer does not do perceptibly more work per day after receiving an increase of pay than he did before. Consequently, the employer is always reluctant to part with his surplus in that way, and frequently has to be compelled to do so through definite collective action on the part of the laborers, by strikes or similar means. This never can take place simultaneously with all laborers at once. All such struggles for direct increase of wages take place by groups or industries. It is now printers, now carpenters, now factory workers, now railroad men, etc. For a general rise of wages to obtain throughout the whole country, it will frequently take from one to two years, and even then some industries may not succeed in getting it. Consequently, the amount of added income to be obtained by the laborers through increase in money wages is, on the whole, slight, and costs a great deal to get it, often involving untold hardships among laborers and creating social disturbances.

"The distribution of wealth to the masses through the lowering of prices is much more economic and satisfactory in every way. It is always simultaneous, and distributes the benefits throughout the entire community. The fall of one or two per cent. in the price of any commodity silently takes its benefits into the home of every consumer of that product. It is more economic than strikes, in that it carries with it no acrimonious struggle of the laborers or disturbance of the community. It is more satisfactory in that it comes gradually and almost imperceptibly, like everything that comes through the normal operation of economic and social law."

In sum, then, the writer of the article reviewed argues that either a rise in wages or a fall in prices—the latter equivalent to appreciating money—is an indication of prosperity in the nation wherein it occurs, while a depreciating currency "is an impairment of the income of actual wealth received by all who live on stipulated incomes."

The Trading World in 1860 and in 1890.

WE here repeat a previous statement that some of the best articles pertaining to industrial sociology appear in the technical papers. When any one of these is prompted to step aside from the strict line of its technical routine to discuss such a question, the topic treated is usually one that has either a direct or indirect bearing upon the special industry or industries to which the publication is devoted, and it is generally a thoughtful, well-prepared essay upon the particular topic discussed. Such an article, in *Engineering News* (Sept. 17), is "The Relative Size of the Trading World in 1860 and in 1896."

It begins with the proposition that "reduction in time and cost in the transport of goods are the two important factors in promoting international trade, or even an exchange of commodities between different parts of the same country." It then proceeds to state what this reduction has been during the three last decades. Thus it is shown that "for all trade purposes" San Francisco is as near to New York now as was St. Louis in 1860, and that this particular instance is a type of the general reduction of time and cost of transport between all parts of the civilized world.

"If we take any date anterior to the introduction of railways, or previous to 1825, we may safely consider each nation separately, from a manufacturing and trading point of view. Each supplied its own wants, mainly from material and labor within its own borders, and was little affected by what its neighbor was doing in a similar line. Foreign trade was practically confined to the import of the luxuries of life, and commercial rivalry could be hardly said to exist,—at least, from the present point of view. Without railways at all, and with highways in a generally very bad condition, intercourse was limited within the boundaries of any one State; and the centralization of population, so characteristic of the present age, was impracticable, owing to the lack of means for supplying such centers with food and other necessaries of life. Up to 1825 the processes of manufacture were still generally crude, and closely followed the practice and traditions of a more remote period. The volume of foreign trade was then relatively large; but this trade was conducted in comparatively small and slow ships, and over seas imperfectly known. The advent of railways and the gradual development of the steam engine and of processes of manufacture brought about a decided change; but even up to 1860 the broad effects of this change were only beginning to be felt, as compared with present events. Clipper-built sailing ships thirty-four years ago outstripped the paddle-wheel steamers on the ocean in the race for foreign markets, and on land railways were, to a large extent, being pushed forward into undeveloped regions, with the resultant growth yet to be realized."

Though the forces that have wrought so great changes were in active operation prior to 1860, that date is arbitrarily selected as a starting-point for the purposes of the article under review, and the increase in the population of North America and Europe during the three decades chosen is noted. The gain has been 123,400,000. Europe and North America alone are considered in this increase, because in the countries of these geographical divisions "scientific and engineering progress had its origin." It might have been added that, with the exception of Japan and the British colonial possessions, it was alone in these geographical divisions of the world that the great triumphs of this progress have been achieved.

"The population of Asia and Africa, now estimated at nearly 1,000,000,000, had little or nothing to do with bringing about present progress; but it enters into commerce as an important factor in inducing western

nations to manufacture for these teeming millions and to utilize the cheap labor found there in supplying raw materials for general consumption. Were this eastern population ever to advance to a competitive point in intelligent productive capacity, the effect upon the rest of the world can only be guessed at by political and social economists; and that there are possibilities in this direction the sudden rise of Japan to the position of a power among nations is a sufficient indication."

The increase in productive capacity corresponding with this growth of population, without increase in the means of manufacturing and transporting products, would have had little or no effect upon the commerce of the world; but the growth of railways from an aggregate of 66,290 miles in 1860 to 390,000 miles in 1893 has supplied facilities for transportation by land in excess of the increased demand for such facilities, while on the sea steam has supplanted sails, and facilities for ocean traffic have likewise greatly increased. In 1860 the steam-ship tonnage of the world was 764,000; to-day it is estimated as over 8,000,000. As a consequence of these advances, and the enormous facilities for verbal communication afforded by quick passages of mail steamers, by the telegraph, and by the telephone, international traffic has more than doubled within the period selected for comparison.

The effects of all these influences upon the social status of mankind are well summed in the closing paragraph of the article.

"But enough has been said to plainly indicate that, while the world's productive capacity, as measured by its gain in population, has normally increased in the last thirty years, the facilities for utilizing this capacity in manufactures and in supplying the world with the product of this labor have grown at an abnormal rate. As before remarked, this world of ours, measured by time and the cost of transport of men and goods from one part to another, is very much smaller than it appeared to be to our fathers. And the immediate effect of this shrinkage is a certain unity of interests throughout the globe, and a sensitiveness to events commercial and financial outside of our own country, that never before existed, nor could exist under previous conditions. The wars of conquest and of personal ambition that so long occupied the time and expended the resources of nations are giving way to industrial wars, within nations and between nations. And, in the adjustment which is now going on everywhere, the present scientific and engineering advance, which has alone made our material and commercial growth possible, must be well and duly considered."

Consular Reforms Needed.

A CRITICISM of the consular system of the United States is made in a paper entitled "A Hindrance to Our Foreign Trade" in *The North American Review* for October. The author is Mr. Thomas R. Jernigan, United States consul-general for China. If, as he says, the defects in our consular system are adversely affecting the interests of our foreign trade, he has done the country a service in pointing out these defects, which are of a character to be easily dealt with. After recounting the incidents of his appointment, his entrance into the consular service in Japan, and his subsequent transfer to Shanghai as consul-general of the United States in China in May, 1894 (which he does to illustrate the principle that interruption of the tenure of office is an embarrassment to the service), he says that a consul entering for the first time upon the duties of his office is at a serious disadvantage with one whose tenure of office has been uninterrupted. He has to learn what has been long familiar to his older colleagues, and is, in the interval of tutelage, not "in a position to measure the importance of the commercial questions arising, and to respond promptly to any fresh conditions which might be developed by a growing commerce." The value of official experience is to an extent thus neutralized by frequent changes.

Fault is also found with the insufficient salaries paid, and with our system of leasing consulate buildings. These features of our service are compared with salaries paid to the consuls of other nations, and

the tenure by which their consulate buildings are held. "The salaried officers of the consulate-general of the United States at Shanghai are: the consul-general, $5,000; vice-and deputy-consul-general, one office with no salary, though the incumbent generally receives the $1,600 allowed the consulate-general for a clerk; interpreter, $1,500; marshal, $1,000; and jailer, $500,—the salaries for the consulate-general proper amounting in all to $9,600. As the consular system of Great Britain is the system to which ours is most nearly kindred, and as the foreign commerce of Great Britain is larger in tonnage and value than that of any other nation in the world, I will take the British system for a standard of comparison.

"The salary of the consul-general of Great Britain is $10,000, with $500 as registrar of British shipping; consul, $6,000; vice-consul, $3,500, with allowance, as assessor to the mixed court, of an additional $1,000; another vice-consul, at $3,250; crown advocate, $2,500; and chief clerk, $2,250. We must also include the salaries paid several student interpreters and under clerks, all of which would make the expenditures about $40,000, or, in round numbers, $30,000 more than the government of the United States expends upon its consulate-general at the great commercial center of Asia.

"The comparison may be extended to the tenure by which the buildings of the consulate-general of these two governments are held. The grounds for the British consulate-general cover about three acres, beautifully laid out, and enclosed by a brick wall over five feet high. Within the enclosure are three large brick buildings, each two stories high, with neat and massive appearance. The center building is for the offices, in which all business pertaining to the consulate-general is transacted. One of the outer buildings is the residence of the consul-general and his family, and the other is for the consul and his family. Both are comfortably and substantially furnished by the government, and supplied with the necessary servants. To support the dignity of his position and extend the influence of his office, the British consul is allowed a certain sum for entertaining." The British consulate buildings are held in fee simple by the British government, and are beautifully situated in an ample, walled inclosure. The American consulate, on the contrary, has been obliged to remove from the convenient quarters it once occupied to less convenient ones, because the salary paid the consul would not permit retaining them at the increasing rent demanded; and, unless other provisions than those now existing be made, the United States consulate is likely to be forced altogether from the foreign concession. Thus the parsimonious way in which our consular service is conducted is anything but conducive to our honor as a nation or to the efficiency of the service, and it affects adversely the influence our representatives abroad are expected to exert upon foreign trade. This state of things contrasts badly with the liberality of the British consular service, and, as it reflects upon our national honor abroad, it should be reformed without delay.

The Trades Union Congress.

AN editorial in *Engineering* (London, Sept. 18) reviewing the recent trades union congress in Edinburgh seems not too indulgent to some of its proceedings, which are criticised with some severity, but concedes that, in the main, the proceedings had very much more of the "business-like steadiness . . . characteristic of Englishmen" than has been manifested at other recent congresses.

It is asserted that the report of the parliamentary committee was "mostly a record of failures." The presidential address dealt with "practical measures rather than theoretical disquisitions." The debate on the report contained reflections upon the international congress, about which "some hard things were said." A resolution was moved for an eight-hours day for all trades, and was adopted by a vote of 211 to 34. Of this vote our cotemporary says "that it was the best thing that could happen, for now the advocates of the hard-and-fast eight-hours day by act of parliament will see how such a measure would

strike a blow at many important industries. Nothing is more easy than a wrong step or a false one; nothing more difficult than to retrace that step, and to avert the consequences which have been incurred."

A resolution demanding an amendment of factory laws with reference to unhealthy trades, and an extension of inspection by operative inspectors, including the inspection of "all vessels and craft in port, river, dock, or canal," was voted unanimously.

On the third day of the convention the reporters of certain Scotch newspapers were requested to withdraw, and, in the act of retiring, were contumeliously hissed. *Engineering* styles this action "one of the follies of the congress." The request that these reporters should withdraw practically amounted to their expulsion, as a resolution to expel them undoubtedly would have followed an attempt to remain. The reason for the request was that the reporters represented non-union papers.

A resolution to nationalize the land, mines, minerals, royalty rents, and railways, and to municipalize all water, artificial light, and tramway undertakings, was adopted by a vote of 172 to 47.

A resolution against the employment in factories during the day-time of children under the age of fifteen years, and, in the night-time, of children under the age of eighteen years, was adopted by a vote of 118 to 105.

Many other resolutions were passed, but they were comparatively unimportant. Those named well indicate the attitude of the British trade unions, and, in the resolution relating to the nationalizing of land, mines, etc., their socialistic tendency is plainly manifested.

GUNTON'S MAGAZINE says "the *Evening Post* is right. After defeating the free coinage of silver, the first step towards giving us a sound currency system is the retirement of the greenbacks. We hope the *Post*, *The Journal of Commerce* and the other papers which recognize the importance of this subject, will continue the campaign of education with increased vigor until the legal tender paper money shall disappear from the currency system. *Nothing but standard coin should be legal tender.* It is high time that this country passed from the era of government fiat money to that of sound business banking." If the sound money advocates are right there can be no other logical conclusion, and we join in urging this measure as an immediate necessity. Standard coin was "the money of the constitution," and standard coin should be the *money* henceforth.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

*8122. Our National Policy and the Industrial Outlook. Cuthbert Mills (Outlining the probable Republican policy in case of McKinley's election). Eng Mag-Oct. 2200 w.

†8135. Saxon Land Credit Association (Translation of the rules and regulations of this association, printed in the belief that the system may be adopted with benefit to the farming community of the United States). Cons Repts-Sept. 7500 w.

†8159. The Farmers and the Silver Movement. Henry Loomis Nelson (An attempt to prove that farmers in the United States have not suffered from the demonetization of silver, as many suppose, or assume, and that low prices for agricultural products are the result of other causes,—notably competition in the world's markets by the Argentine Republic, India, and Russia, and a greatly increased production). Bankers' Mag, N. Y.-Sept. 2800 w.

*8182. Commercial and Industrial Progress in Japan (Compiled from returns published in Japan for the two years, 1889 and 1895, from which an estimate of progress since 1889 can be made). Engng-Sept. 4. 700 w.

8203. The Influence of Money in History (Historical review). Min Ind & Rev-Sept. 10. Serial. 1st part. 2000 w.

8271. The Relative Size of the Trading World in 1860 and in 1896 (A well written, thoughtful and suggestive editorial with statistics of the growth of railway and marine facilities for transportation, compiled from authoritative sources). Eng News-Sept. 17. 2500 w.

8314. American Trade Prospects on the Baltic. Charles E. Currie (The author, special commissioner of the Louisville, Ky., Board of Trade, gives favorable views of the prospect for extension of American trade with northern Europe). Bradstreet's-Sept. 19. 2000 w.

†8350. Hangchow, the New Treaty Port of China (Concise but full report of the industries

We supply copies of these articles. See introductory.

of the province of Chêkiang, and the future prospects of Hangchow, its capital, as a treaty port. The city of Ningpo is said to be the richest city in China, and it is the center of the most extensive silk and tea districts in the world). Cons Repts-Sept. 24000 w.

†8355. United States Trade with Uruguay (Information given in reply to numerous letters of inquiry). Cons Repts-Sept. 1600 w.

*8387. Municipal Reform. William Howe Tolman (The general awakening to the need of municipal reform, and what is necessary to effect the desired changes). Arena-Oct. 3500 w.

8393. A Fiat Money Experiment in the Past (Review of "Fiat Money Inflation in France," by Dr. Andrew D. White, recently issued by D. Appleton & Co. History of the French assignats). Bradstreet's-Sept. 26. 1400 w.

8394. Foreign Governments in Default (Information supplied by the Corporation of Foreign Bondholders, a London institution organized to supervise the interests of British investors). Bradstreet's-Sept. 26. 900 w.

*8399. China: Her Resources, Openings, and Opportunities (A general review of the industries and present requirements of the people of China, and the possible and perhaps probable industrial awakening that awaits this most conservative of nations). Mach, Lond-Sept. 15. 3000 w.

*8417. Foreign Import Duties on Wheat Flour (Tabulated statement). Bd of Trd Jour-Sept. 250 w.

*8418. Tariff Changes and Customs Regulations (Russia, Norway, Germany, Belgium, The Netherlands, France, Portugal, Spain, Italy, United States, San Domingo, Venezuela, Brazil, Peru, British India, Barbados and Gambia). Bd of Trd Jour-Sept. 5000 w.

*8429. The Trades Union Congress (Editorial review of the congress, the addresses delivered, and the probable effect of its proceedings upon the status of labor in the United Kingdom and in other countries). Engng-Sept 18. 1800 w.

*8475. How to Recover Our Waning Trade (The first part considers the advisability of abandoning rigid adherence to free trade as a national policy and intimates that its full maintenance is not compatible with British commercial prosperity). Ir & Coal Trds Rev-Sept. 18. 2200 w.

*8488. Free Coinage and Life-Insurance Companies. John A. McCall (Reply to the assertion of Mr. Bryan in his speech of acceptance, that a rising standard must be of more benefit to the companies than to the policy holders). Forum-Oct. 2500 w.

*8489. Free Coinage and Trust Companies. Edward King (How the free coinage of silver would affect those whose property is in the special care of trust companies). Forum-Oct. 1800 w.

*8490. Free Coinage and Farmers. John M. Stahl (The direct effect will be that which the free silver advocates declare it their object to avoid). Forum-Oct. 2800 w.

8494. Drawback Rates (Summary of the United States revised drawback regulations upon all articles which have been granted the rebate privileges conferred under the provisions of Section 22, of the present tariff law). Ir Age-Oct. 1. 3000 w.

†8508. A Hindrance to Our Foreign Trade. Thomas R. Jernigan (The hindrance herein noted arises from defects in our consular service as related to China. These defects are severally pointed out and their effects upon trade stated). N Am Rev-Oct. 3600 w.

†8525. Why American Industry Languishes. Hilary A. Herbert (Fear of the future, and agitation for free silver are the causes assigned, and to the substantiation of which the argument is directed). N Am Rev-Oct. 2500 w.

*8573. Economic Effect of Appreciating Money (Combats the fundamental idea behind all "cheap money" theories, viz,. that national prosperity is promoted by depreciating money). Gunton's Mag-Oct. 3500 w.

*8574. Government by Injunction (Opposition to the United States court injunctions for preventing and controlling strikes is justified, and it is maintained that in the Ann Arbor and Chicago strikes a new and unanticipated use of the power of injunction was made, which cannot be defended on general principles). Gunton's Mag-Oct. 2500 w.

*8575. The Foreign Market Delusion (Combats the proposition that the greatness of a nation depends upon the extension of its foreign markets. The theory is alleged to have been borrowed from Manchester economics of half a century ago). Gunton's Mag-Oct. 1000 w.

*8576. Strikes in Russia (Translation of a letter to the Belgian *Independence* from its correspondent in St. Petersburg. An account of the labor movement in Russia. Peaceful methods as yet prevail with no sign of disorder). Gunton's Mag-Oct. 1700 w.

*8577. The Industrial Development of the Extreme Orient (Combats the gloomy view some are taking of the effect of industrial development in the Orient upon industry in other parts of the world, and thinks it will result in benefit rather than injury). Gunton's Mag-Oct. 1800 w.

*8578. The March of Invention (Review of the last United States patent office report). Gunton's Mag-Oct. 1800 w.

*8579. The Economics of Organized Charity. Rev. M. McG. Dana (The questions now faced by charity are regarded as essentially economic, relief being a mere temporary expedient, while the main study is the improvement of conditions producing distress). Gunton's Mag-Oct. 1900 w.

*8580. Convict Labor (Review of Bulletin No. 5 of the National Dept. of Labor. Summary of statistical information therein given). Gunton's Mag-Oct. 1200 w.

*8649. The Reflux of Gold to America. W. R. Lawson (The return of gold to America is treated as nothing remarkable, especially when the enormous export of silver during the period of this reflux is taken into account. United States treatment of the money question is sharply criticised). Bank Mag, Lond Oct. 4500 w.

MARINE ENGINEERING

Electricity in Marine Engineering.

THE extent to which the successful application of electricity to marine use has been carried and its possible and probable future as an adjunct of marine engineering form the theme of a serial paper by Lieutenant B. A. Fiske, U. S. N., in the *Electrical World* (Sept. 23).

For a long time the magnetic compass was the only application of electric energy used as an aid to navigating the high seas. It is quite safe to say that without this aid no great ocean would ever have been crossed, except perhaps by some unfortunate ship blown out to sea in spite of human effort to prevent such a catastrophe. So great would have been the hazard of such an undertaking that the boldest would have shrunk from it; and the phrase "a ship without a compass" has become proverbial as descriptive of a type of action uncontrolled by principle. No other application of the great store of electric energy which modern science has shown to pervade the universe will ever be so far-reaching in its effects as the first and greatest. It is, therefore, with some surprise that we fail to find in the introductory to Lieutenant Fiske's paper any reference to it, unless the allusion to "better control of a ship" in the following quotation implies the use of the compass. We think, however, that the author did not have the compass in mind when he wrote the passage. He says:

"In examining the results of the use of electricity in naval life, we must admit that, up to the present time, electricity has fulfilled all the promises it has given us. It has made our ships brighter, cleaner, and healthier; it has lightened the task of enforcing discipline; it has increased the accuracy of gunnery; it has made instruction interesting; it has assisted the surgeon in diagnosing wounds and relieving pain; it has given the captain better control of his ship, and the admiral better control of his fleet; it has added an element of intelligent interest and expectation to each new addition to our navy; and it has brought into active sympathy with the sea-going class a large and influential body of progressive men on shore."

All this is true of the modern marine electrical appliances which form the staple topics of the paper.

A difficulty with which the introduction of electrical aids to the working of ships has had to contend is found in the lack of any incentive for officers and men to study electricity; and the slowness with which these devices have come into use is, therefore, not surprising. The fact that the use of electricity on ships has so much extended already is rather an indication that seamen are more progressive than is generally supposed.

In our department of electricity will be found a review of a paper recounting the troubles of electricians at sea, in which many difficulties not encountered on land are set forth. It would appear that Lieutenant Fiske takes an opposite view, and regards a ship as presenting exceptionally easy conditions for the installation and operation of electric machinery and appliances.

"It is frequently stated that the reason for the slow progress of electricity in naval matters is the difficulty of meeting the conditions of ship life; but this position is hardly tenable, because the conditions for the use of the electric light, electric motors, and telephones in warships are in reality not nearly so severe as they are in hundred of positions along the coasts of the country and through the long stretches of the mountainous and comparatively unpeopled sections of our western lands. In reality there can hardly be found, outside of the college laboratory, conditions which are in many respects so favorable as those to be met on board a modern warship. In the first place, the distances through which the electric current are to be transmitted are extremely short; in the second place,

the item of expense does not control to so great a degree as it does in the operations of commercial life; in the third place, in case of any accident or derangement, the place where this accident or derangement occurs is always within a few feet of somebody, so that it will not have to be hunted for, as frequently happens with apparatus on shore, through miles of country; in the fourth place, the solidity of the structure of a ship and the excellence of all of the mechanical appliances are in great contrast with the flimsiness of the structure and the cheap character of the installations which have, for financial reasons, in many cases to be made on shore."

The rivalry between electrical and mechanical devices which has been in progress on land also reaches into marine engineering. For instance, in signalling there are electrical methods and methods purely mechanical; a bell may be rung by pulling a wire, or by an electric current sent through the same wire, and so on.

"In spite, however, of the successful efforts of the genius of electricity in ameliorating the conditions of shipboard life, there are still many objectors; and it is a fact that a contest is going on between electro-mechanical and other mechanical apparatus in very many of the important operations in ships and forts, which promises to be as lasting and as bitter as the contest between steam and sails; and yet it is easy to one who watches the drift of modern engineering practice to see with which the ultimate victory will reside. Just now the fight is going merrily on, and the public benefits by the competition. No sooner does an electrical device score a success than some ingenious person does the same thing with mechanics; and no sooner does an important mechanical invention accomplish some new thing than an electrician throws it altogether into the shade by a novel use of electricity. It may be stated as a general law—but with the distinct understanding that it is only general—that mechanical appliances have the advantage of greater simplicity of principle, and that electrical appliances have the advantage of greater simplicity of operation. To paraphrase this statement, mechanical appliances are more easy to understand, but electrical appliances are more easy to use. Mechanical appliances require less instruction for their use; electrical appliances render available a higher grade of intelligence, and also require a higher grade of intelligence. Electrical appliances strive for an idea; mechanical appliances do what is required at the moment. The advantages of maturity and experience are on the side of mechanical apparatus; but youth and the promise of the future reside with electricity. Mechanical appliances are less apt to deteriorate from disuse; electrical appliances are less apt to deteriorate from use. Mechanical connections are liable to give out under the sudden strain of emergency; electrical appliances, from their nature, suffer little strain in use, and are not apt to fail in emergency, if found to be in good condition before the emergency occurs. A mechanical connection, if broken or injured, gives plain sign of the whereabouts of the trouble, but the trouble is with difficulty repaired. A trouble in an electrical connection is sometimes hard to find, especially if the apparatus is not thoroughly understood, but, when found, is remedied with ease. The difficulty of repairing a break or disarrangement of a mechanical appliance, caused by a stress, is usually in proportion to the greatness of the stress; but, with electrical appliances, the cause of trouble is usually minute, and can be repaired as soon as found."

The slipshod manner in which much of the shipboard electrical work is done has tended to retard progress. It is this, more than anything else, that has given rise to complaints of the untrustworthiness of electricity. "It has always been so easy to put in a battery, or a bell, or a dynamo, which would work for a week that in very many cases it has not worked any longer." Notwithstanding, electricity is becoming more widely used at sea, and the era of the slipshod work above deprecated is, let us hope, coming to an end.

The paper treats marine electrical appliances under the following heads: Electric Lighting; Electrically-Operated Steam Whistles; Motors. The advantages and

disadvantages of steam and electric motors for special marine purposes are compared and discussed.

The Immediate Future of Lake Traffic.

THE improvements in the river system of our great lakes, allowing for the safe passage of vessels of much heavier draft, and the great increase in length and tonnage of vessels engaged in lake traffic, have, according to the Duluth *News-Tribune* (quoted by *Seaboard*, Oct. 1), inaugurated a new epoch in the history of the lake marine, which will be fully developed at, or shortly after, the opening of next season's navigation.

Of Duluth as a lake port it is said that the improvements, as regards draft of water in rivers connecting with the lake system, place it on an equal footing with Chicago, and grain can now be shipped from that point for the same freight charge as from Chicago. With the completion of the waterway between Duluth and Buffalo, it is predicted that lake freights will fall to a lower average than at present rules. A most potent influence in reducing freights will be the many five-thousand-ton vessels lately built. These "four-hundred footers," as they are called, carry 4,500 tons with a draft of fifteen feet; and, when they can load to seventeen feet, they will be able to compete for freights with lower rates than have ever been possible before.

"Vesselmen are of the opinion that the big fellows will crowd many of the little ones out of the carrying-trade next season. A prominent vessel man of Duluth says that such an effect is inevitable, as one of the larger class of vessels can be operated at a cost of only ten per cent. in excess of the cost of operating a vessel of two thousand tons. The big vessels, therefore, can continue in the carrying-trade, and pay dividends where the small vessels would do business at a loss. It is claimed the big vessels can carry ore from Duluth to Erie at fifty cents a ton, if the rate should go down to that figure, but this is denied by well-informed vesselmen. Captain McDougall once made the statement that he could carry ore for that price, but there are other vesselmen that are skeptical, unless, they say, the captain means he could carry it at a loss. Captain McDougall, in making that assertion, contemplated whaleback steamers with tow barges to transport the ore. In any event, the day of dollar ore and six-cent wheat has gone, never to return except under some extraordinary combination of circumstances. Whether the change will be for the better for the owners of lake-vessel property remains to be seen. The vessels of two thousand tons' carrying capacity, of which there is a large number, have been great money-makers in the past, and it is assumed they will continue to be profitable property in seasons of heavy freight movement; but the days of their glory have departed."

There have been many record-breaking cargoes during the season about to close. "The Coralia started the record-breaking in ore, and the Rees in wheat. The Coralia still holds the ore record at 5,088 gross tons. The Lake Superior ore record is held by the Bessemer, which loaded out of Duluth 4,172 gross tons a week ago. The Lake Superior ore record has been shifted from one to the other of three vessels this season,—the Queen City, Aurania, and Bessemer. It is expected the Queen City will take the ore record from the Bessemer before the end of the season. The Bessemer's ore record is only three tons better than the Queen City, as it now stands. The Queen City holds the record for the heaviest cargo of any commodity ever floated on Lake Superior, however. It consisted of 157,000 bushels of wheat, or 4,710 tons. The Queen City is the greatest carrier on the entire lake system, despite the performance of the Coralia already mentioned. The Coralia's cargo of ore represented in net tons 5,700, but she drew so much water that she had to lighter to get to her dock. The Queen City carried 207,500 bushels of corn out of Chicago a short time ago without attracting much attention, but it was the greatest cargo ever loaded on the lakes, amounting to 5,810 net tons. As the Queen City carries a greater cargo on the same draft than any other boat, it is presumed she can protect the records she has made the past summer, until something new is produced

that can eclipse her performance." However, the Queen City is likely to have a rival in a new vessel contemplated by The American Steel Barge Co., which is expected by some to break all the records of cargoes hitherto transported on the great North American lakes.

The Safety of Modern Ships.

THE table herewith presented gives the total number of registered vessels belonging to the United Kingdom—exclusive of fishing vessels—lost at sea during each of the fifteen calendar years, 1881-1895, and of the lives of crews and passengers lost in them.

In a paper read before the British Association Dr. Francis Elgar presented this table, and remarked upon the increased safety of modern passenger-ships, as shown by the statistics of the British board of trade. Taking the last six years first,—namely, from the end of 1889 to the end of 1895,—no regular passenger steamer of any size or class whatever was lost during that period, except by collision, stranding, or fire. Surely, this is a remarkable result, and one showing that the principal matters now requiring attention are precautions against stranding and collision, and the internal subdivision of the hulls of ships so as to make them as safe as possible in the event of injury. In 1895 only 23 lives of passengers in steamers were lost through the loss of the steamers. This does not include any lives lost in minor casualties. In 1894 the lives lost through the loss of steamers numbered 1,157, 1,150 of which were Chinese soldiers lost in the Kowshing, sunk by a Japanese man-of-war; in 1893, 27 passengers; in 1892, 67 passengers,—44 in the wreck of the Roumania on the coast of Portugal, and 20 in the loss of the Bokhara on the Pescadores; in 1891, 6 passengers; in 1890, 142 passengers, 98 of whom were lost with the Quetta in Torres Straits; while in 1888, 712 passengers were lost, these including 703 passengers of the small steamer Vaiturna, lost near Bombay.

The ships as designed and constructed have successfully defied the worst efforts of wind and sea to send them to the bottom, so long as they were navigated clear of obstructions, and were protected against fire. One of the chief lessons taught by a study of the statistics of losses, and of the principal causes of loss of ships to-day, is the necessity of endeavoring to make ships as safe as possible by internal watertight subdivisions, in the event of injury through collision or stranding. There appears no reason why large passenger steamers should not be subdivided, so as to be safe against the effects of any single blow from outside, and this is the case with many of the fine steamers, transatlantic and others, that trade from this port. The case may be different with regard to many cargo steamers; it may not be possible to make them absolutely safe by the same means, without rendering them valueless for trading purposes.

	Steamships.			Sailing vessels.			Total.		
	Vessels lost.	Lives lost.		Vessels lost.	Lives lost.		Vessels lost.	Lives lost.	
		Crews.	Pass.		Crews.	Pass.		Crews.	Pass.
1881	185	636	196	645	1004	17	780	2240	213
1882	146	601	14	458	871	16	604	1472	30
1883	142	772	67	470	1123	21	612	1895	88
1884	146	377	129	334	667	75	480	1044	204
1885	126	440	33	304	634	17	430	1074	50
1886	126	351	32	394	644	15	520	995	47
1887	128	633	87	252	519	267	380	1152	352
1888	100	354	712	287	547	56	396	898	768
1889	105	301	31	215	391	20	320	692	51
1890	129	427	142	235	664	18	385	1091	160
1891	129	320	6	319	695	12	448	1025	18
1892	90	359	67	207	633	31	297	992	98
1893	122	521	27	241	483	9	363	1004	36
1894	128	379	1157	214	546	8	342	925	1165
1895	100	322	23	195	637	20	295	959	43
Total for 15 years	1901	6820	2721	4971	10,648	602	6652	17,468	3323

With reference to water-tight bulk-heads Dr. Elgar maintained that ships should be so designed that they would float with any two departments full, and that the two engine rooms should be divided by a middle-line bulkhead, as otherwise a slight injury to one might involve the entire loss of propelling power. Notwithstanding the attention given to this subject, most sailing ships have only a collision bulkhead.

IT is announced that the Belgian government is about to begin the construction of a very extensive system of docks at Ostend at a cost of about $5,000,000. These docks will completely supplant the quays of the old harbor, and are to extend inland to a distance of between one and two miles. The warehouses will be built after the model of those at Antwerp, and a railway system will run around the docks.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

*8163. The Mercantile Ship-building of the World (Compiled from the carefully prepared statistical tables of the committee of Lloyd's Register of British and Foreign Shipping). Eng's Gaz-Sept. 1600 w.

*8164. Marine-Engine Design of To-Day. Henry M. Rounthwaite (A paper read at the Inst. of Junior Engs. A general review of the present features of marine design, both for merchant vessels and military purposes, but principally related to merchant service). Eng's Gaz-Sept. 4000 w.

*8169. Boiler of the Steam Yacht Scud (Illustrated description of a Blenchynden boiler placed on this yacht). Eng, Lond-Sept. 4. 900 w.

*8172. Fundamental Corrections on the "Admiralty Formulas." Robert Mansel (The position is taken that either Newton was wrong in the enunciation of his scholium to the third law of motion, or that the variable Admiralty constants are a misapprehension. In pursuance of the subject mathematical methods are employed). Eng, Lond-Sept. 4. 3000 w.

*8178. Caissons for the New North Docks, Liverpool (Illustrated description). Engng-Sept. 4. 700 w.

*8179. Electrically Driven Machine Tools for Naval Construction (Illustrated description of a number of portable tools recently introduced into the arsenal of the Austrian Lloyd's at Trieste). Engng-Sept. 4. 500 w.

*8180. The Reorganization of the French Marine (Editorial review of the proposed reorganization, which is expected to lead to a higher standard of efficiency). Engng - Sept. 4. 2500 w.

8236. Experiments with Ship Models (Illustrated description). Sci Am Sup-Sept. 19. 1500 w.

*8289. The French Naval Manœuvres (Illustrated description with particulars of the armored ships that participated). Engng-Sept. 11. Serial. 1st part. 2200 w.

*8310. The Five-Crank Engines of the S.S. Inchmona (General description with two-page illustration). Eng, Lond-Sept. 11. 2200 w.

*8377. From Light to Light. Kirk Munroe (A description of the Armeria, one of her regular cruises, the light-houses supplied by her, the supplies delivered, and customary incidents of such a cruise. Popular and entertaining style. Illustrated). Scribner's Mag-Oct. 7300 w.

8383. Electricity in Naval Life. B. A. Fiske (An examination of the results of electricity in naval life, in which it is affirmed to have fulfilled all its promises). Elec Eng-Sept. 23. Serial. 1st part. 2500 w.

8389. Electrical Features on the "St. Paul." (Interesting illustrated description). Elec Wld-Sept. 26. 2700 w.

*8431. On the Relation of Speed and Displacement in Racing Yachts. J. T. Bucknill (A mathematical thesis by Colonel T. English, which it is stated proves that in yachts of the present type, the speed varies as the twelfth root of the displacement). Engng-Sept. 18. 900 w.

8495. Government Dry Dock at Port Orchard, Puget Sound, Washington. A. McL. Hawks (Illustrated description). Sci Am-Oct. 3. 1300 w.

8496. The Disinfecting Boat of the New York State Board of Health (Illustrated description of the vessel and its disinfecting appliances, bath, sulphur furnace, and disinfecting oven). Sci Am-Oct. 3. 800 w.

8497. Electric Turret for Armorclads. From *La Nature* (Illustrated description). Sci Am Sup-Oct. 3. 700 w.

†8509. Our Neglected Shipping. Alex. R. Smith (An argument for the protection of American shipping by means of discriminating duties, taxes, etc). N Am Rev-Oct. 3300 w.

*8527. The United States Armored Cruiser "Brooklyn" (Illustrated description). Am Eng & R R Jour-Oct. 1800 w.

8529. The New Era on the Lakes (The improvement of lake ports, and the increase of the size of lake vessels have inaugurated the era discussed, in which Duluth, it is anticipated, will rival Chicago in the lake commerce. From the *Duluth News-Tribune*). Sea-Oct. 1. 1100 w.

8552. The Discovery and Repairs of a Break in the Intermediate Steam Chest of the Port-Engine on the U. S. S. Philadelphia. W. N. Little (Illustrated description), Power-Oct. 1400 w.

8554. Official Speed Trial of the Armored Cruiser Brooklyn. W. N. Little (Description of the vessel and summary of data obtained during the trip). Power-Oct. 2000 w.

*8566. H. M. S. "Powerful" (The first part treats of the boiler installation. Illustrated description). Engng-Sept. 25. 3000 w.

*8571. Safety in Ships (Discourse delivered before the British Assn., by Dr. Francis Elgar. The primary conditions of safety are treated at length. Appendix giving number of vessels lost at sea from 1881 to 1895 inclusive, with particulars). Eng, Lond-Sept. 25. 4700 w.

8650. Marine Engineering (Written for the purpose of giving to young men intending to become sea-going engineers an idea of the conditions and work in this occupation). Lord's Mag-Oct. Serial. 1st part. 1200 w.

*8652. The Mercantile Ship-Owning of the World (Tabulated statements of the number and tonnage of vessels and the countries to which they belong . Eng's Gaz-Oct. 1600 w.

*8653. Engines of the Paddle-Steamer "Princess of Wales" (Illustrated description). Eng's Gaz-Oct. 500 w.

We supply copies of these articles. See introductory

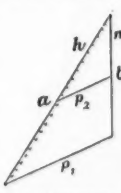
MECHANICAL ENGINEERING

The Prytz Planimeter.

CAPTAIN H. PRYTZ, the inventor of the original stang planimeter, contributes two communications to *Engineering* (Sept. 11). The first of these refers to the illustrated description of the so-called Scott planimeter, reviewed in our October number, and the second to an illustrated description of Professor Goodman's instrument, in which compensation for error is made by a scale with increasing divisions. It is fair to Captain Prytz, who implies an unjust appropriation on the part of Mr. Scott, and who also criticises the form of the instrument claimed by the latter, that his letters should be reviewed here, more especially as in our October review we—perhaps rashly—expressed approval of the Scott instrument. It seems that in this Captain Prytz disagrees with us. He says:

"At first the simple form, contrasting with the complicated theory, puzzled men who took an interest in planimeters; but, as theory showed that the instrument could not, as all other planimeters, give a mathematically correct result, though it gave certain limits within which this result must lie, it could not get into popular use till the practical man took it in hand. He had felt the inconveniences of the complicated instruments, which are easily put out of order by dust and careless usage. After my planimeter has been tried in practical use, especially in England and Germany, its useful results won credit to such a degree that the abovementioned defect was nearly forgotten. When Mr. Scott asserts that the stang planimeter is as accurate as, if not more so than, the Amsler, he goes too far, especially if the due proportion between the length of the instrument and the dimensions of the figure to be measured be not maintained."

"By measuring with the stang planimeter its keel produces two marks on the paper; the distance between these is measured on an ordinary scale by help of a pair of compasses. As the area is equal to this distance multiplied by the length of the instrument, you see that, if this length is one foot, the distance gives directly the area in square feet; if you give the instrument double or half the length, the distance between the marks will give respectively the half or the double of the area; when it is desired to measure an area that is very little in proportion to the length of the instrument, the distance between the marks is so small that it can scarcely be measured accurately enough on the scale; the fault in per cent. grows as the distance diminishes, but this inconvenience may be removed by circumscribing the area two or more times before the end mark is set, as is indicated in the short explanation that accompanies every instrument. If, on the contrary, an area be measured whose dimensions greatly exceed the half length of the instrument, the error of the formula will be serious and in a much increasing degree, when with greater and greater areas, so that at last the result grows totally erroneous. This inconvenience can only be removed by dividing the area and measuring the separate parts. If areas of very different sizes are to be measured, either two instruments of different length must be used, or the somewhat longer process necessary in order to remove the one or the other inconvenience must be followed.



"Last year Coradi, in Zurich, showed me a stang planimeter with a wheel instead of a keel; the wheel could be moved along the stang, but he allowed that the original simple form was the best and surest. Mr. Scott has adopted these two transformations; but I must remark that, when the edge of the keel is grown dull, it is easy for any one to sharpen it a little. A wheel

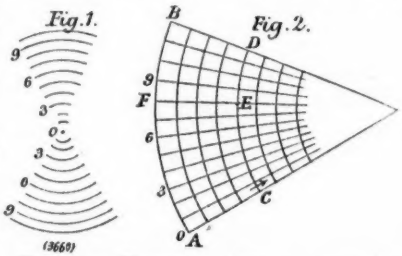
must ever be more sensible to dust and rough usage, and the more, the sharper and more accurately constructed it is. As for area-measuring, there can be no imaginable cause to have a changeable length of the stang; and, as to measuring the mean height, I also prefer the constant stang, and transferring the result on a scale by one of the usual ways, as on the figure above, where a is the constant length of the stang, b the basis of the diagram, m the distance between the marks made in the paper by the keel, p_1 and p_2 two parallel lines, and h consequently the mean height, $a\ m$ being like $b\ h$.

"In the above-mentioned transformations there is nothing opposed to the theory of the instrument; but not so with the celluloid plate that Mr. Scott proposes instead of the tracing-pointer. When this instrument rests something more on the one or the other side of this plate, you will measure the area circumscribed by this or these resting-points, and not the desired area. There is no guarantee that these areas are not of different sizes; it must, therefore, be most undesirable to change the tracing-pointer into a flat plate. It is better to accustom yourself to the management of the pointer as it is, and this presents no difficulty that is not to be overcome.

"The recording-discs that Mr. Scott fixes to the instrument have nothing to do with its working, provided the weight is equal on both sides of the instrument. It is an ingenious invention, but not new. I would prefer to have a graduated plate for the keel to slide upon. Cornelius Knudsen, in Copenhagen, the manufacturer of the original stang planimeter, is about constructing such a plate, where you may read immediately the wandering of the keel in straight line.

"I wonder why Mr. Scott puts his name to the instrument instead of mine. He has on no point changed the principles for its use as a planimeter, and all the 'improvements' that he proposes are not new."

With reference to the tracing-points of the Goodman instrument, Captain Prytz says their form is bad, and that, if Professor Goodman "had done as his colleague at Stuttgart, Professor Hammer, had,"—that is, "examined first an original planimeter (see *Zeitschrift für Instrumentenkunde*, 1895, März, Berlin, page 90),—he would no doubt have found that there was not at all cause to alter the form of the instrument, which for areas from $\frac{1}{16}$ to $\frac{1}{8}$ of the square of the planimeter length, according to the numerous experiences of



Professor Hammer, gives an error less than 1 per cent. Further, if Professor Goodman had examined closer the theory of the instrument, he would have found that $R^2 = \frac{1}{18}(a^2 + b^2 + c^2)$, when the area is a triangle with the sides a, b, c, and that $R_2 = \frac{1}{6} d^2$, when the area to be measured is a rectangle with the diagonal d; when this rectangle grows thinner and thinner, d approaches to the greatest side a; and, when the area has become a straight line a, is $R^2 = \frac{1}{6} a^2$, and the correction $\frac{R^2}{4p^2} = \frac{a^2}{24p^2} < \frac{1}{96}$, or about 1 per cent., when you observe the due proportion between area and planimeter; so you will see that the Goodman correction, where R is ever taken from a circle, is totally illusive; the best correction for $\frac{R^2}{4p^2}$ is that given in the construction of the original instrument, whose length, you will observe, differs a little from the declared length.

"I, must counsel the engineers, rather than use the 'improved stang planimeters,' to let a country blacksmith make them a copy of the original instrument, and, if they wish to avoid measuring or calculat-

ing after a common rule, then, themselves, to draw on the paper whereupon the keel glides a scale, as on Fig. 1, for area-measuring, and, as Fig. 2, for middle-height measuring. The arrow in Fig. 2 indicates the direction of the stang. The chord A B = length of the planimeter; C D = length of the diagram; C = first position of keel; E = last position of keel; A F = middle height of the diagram. C D. A F = A B. C E."

The Practical Limit of Steam Pressure in Engines.

IT were premature to aver that this limit has been already reached; but we believe that most competent engineers think it has been nearly approached. Our able co-temporary, *The Engineer* (London, Sept. 25), editorially discusses the likelihood of increase in the working pressure of steam, its remarks being in the nature of a reply to a number of correspondents urging the use of higher pressure. One of these advocated even a pressure of one thousand pounds per square inch, believing that the employment of this pressure would reduce coal consumption to considerably less than one pound per h.-p. hour.

There appears to be in the minds of some a disposition to give the reduction of fuel-consumption for power-production an undue importance. This importance it has held until recently, and reasonably so; but coal-consumption has now been reduced to a figure such that a saving of a considerable percentage would be of small pecuniary importance, if it were gained at the expense of other things also essential.

Suppose that we ultimately reach a point where all large steam-power installations use not more than one pound of coal per h.-p. hour, and that, by carrying higher pressure, we could generate one horse-power with nine-tenths of a pound of coal. With an engine of one-thousand horse-power we could thus save one-half a ton of coal in a ten hours' run. A ship with engines of ten thousand horse-power would save twelve tons per day, so that an Atlantic liner would need to carry and consume about seventy tons less per trip. The cost of this coal, plus the receipts for carrying seventy tons of paying freight, would represent the credit side of the account; the debit side would include increased hazard, increased repairs, greater skill in attendance, more wear and tear, greater fixed charges, etc. We submit that, when increase of debits equals the gains, the practical limit will have been reached. Perhaps it may already have been reached,—a fact which it may take some time to demonstrate. *The Engineer* says:

"Among practical ship-owners there is a growing disposition to run up pressures. Instead of the normal 160 pounds, we constantly hear now-a-days of 180 pounds, 200 pounds, and even 225 pounds. Between this last, however, and 1,000 pounds there is still a great gap, which will not be crossed in a hurry. But it will not be out of place, perhaps, to direct attention to certain facts which, it seems, are in danger of being forgotten.

"The ship-owner cares nothing at all for the consumption of coal per h.-p. per hour. His interest in the machinery of his ship begins and ends with the aggregate sum he has to pay for conveying a ton of goods any convenient unit of distance,—say, 100 miles. Now, this price paid covers not only coal, but many other things as well. The ship-owner knows that his boilers and engines depreciate so rapidly that it is not safe to allow less than 15 per cent. per annum on the first cost for depreciation and interest. Then lubrication is an important item; so are the wages of the engine and boiler-room staffs. It is true that, by augmenting pressures and ratios of expansion, coal may be saved; but, on the other hand, it is possible that the whole saving may be swallowed up by augmented expenses peculiar to extreme pressures."

An example of some of the minor difficulties in the carrying of high-pressure steam is the impossibility of obtaining suitable glass gages. "Jacob Perkins was compelled to use talc instead of glass, and this made a very unsatisfactory gage. The glass softens or decomposes rapidly, and loses its transparency. This is one reason why so many patents have been taken out for electric gages and low-water detectors. It ought, of course, to be possible so to

scheme a gage that it will always be cool, in much the same way that a pressure gage is kept cool; but this has not been done yet. Another difficulty lies in the furnaces. Their diameter must be kept down, and this gives a contracted fire-space. Of course water-tube boilers may be used, but they have not yet established their reputation in the mercantile marine; and we write now of things as we have them, not as they may be in half-a-dozen years. Another trouble is found in the manhole packings, in the feed-pumps, and in every cock and joint about the boiler, from the steam whistle up. These difficulties are not insurmountable, but to get over them entails outlay. This is the fact on which we wish to insist. Every one, in short, who has had any experience with high-pressure steam knows that it is a very different thing from low-pressure steam; and that, whereas its sole virtue is that it saves coal, its many defects may very easily make the ship-owner regret that he ever adopted it."

Another Improved Planimeter.

ATTENTION to the subject of planimeters has been recently aroused in the mechanical world by the publication of alleged improvements. One of these (Scott's—so called) was illustrated and described in this department for October, and we herewith present a review of an illustrated description of another form, devised by Professor Goodman of Leeds (*Engineering*, Aug. 24). The "hatchet" planimeter, otherwise called the "stang" planimeter, was, as stated in our October number, invented by Captain H. Prytz of Aarhns, Denmark. The publication of Mr. Scott's article and the description of Goodman's planimeter have called out two interesting letters from Captain Prytz, printed in *Engineering* (Sept. 11), and noticed elsewhere in this department. We herewith present a reduced engraving of Professor Goodman's instrument, and a condensed descriptionof it.

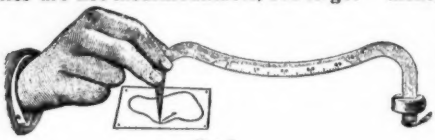
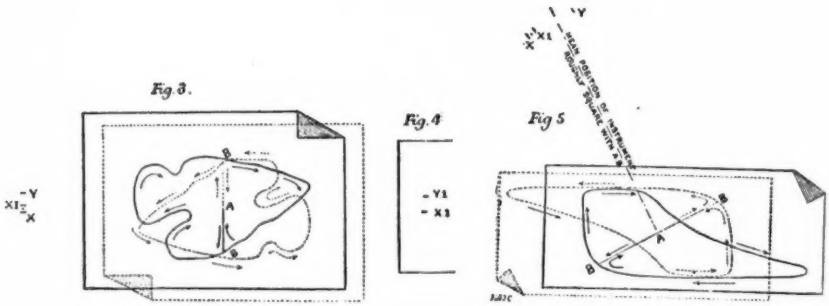


FIG. 1.

FIG. 2.



GOODMAN'S HATCHET PLANIMETER.

There are two forms of the instrument, one used for measuring areas and surfaces, and the other for measuring the mean height of diagrams.

"The method of using the two instruments is practically the same. In order to familiarize one's self with the peculiar action of the instrument, it will be well to get a large sheet of paper on a drawing-board or a large blotting-pad, and, holding the instrument vertical to the paper, grasp the tracing leg very lightly indeed between the forefinger and thumb of the right hand, with the hatchet toward the left hand, as shown in Fig. 1. Then by moving the tracing-point round and round an imaginary

figure, and allowing the hatchet to go where it pleases, it will be seen that the hatchet moves to and fro along zigzag lines, and travels sideways,—the side travel being nearly proportional to the area of the figure described by the tracing-point. If the tracing-point be too tightly grasped, the hatchet will not move freely, and will have a side slip. When this occurs, the side travel of the hatchet ceases to be proportional to the area traced out. A loose weight is hung on the hatchet to prevent this side slip, but, with a little skill, this weight may be dispensed with.

"When measuring the area of a surface like that shown in Fig. 3, a point, A, is chosen somewhat near the center of the figure; the exact position is, however, immaterial. From the point, A, a line, A B, is drawn in any direction to the boundary; the tracing-point of the planimeter is now placed at A, with the hatchet at X, Fig. 3,—that is, with the instrument roughly square with A B. The hatchet is now lightly pressed, in order to mark its position on the paper by making a slight dent; then, leaving the hatchet free to move, as shown in Fig. 1, the tracing-point is caused to traverse the line, A B, and the boundary line in a clockwise direction, as shown by the arrows, returning to A *via* A B. The hatchet will now be found to have taken up a new position, Y, which must be marked by again pressing the hatchet to make a slight dent in the paper. If the figure under measurement be on a separate sheet of paper, the paper must now be revolved about the point, A, through about 180 deg. (by eye), using the tracing-point of the instrument as a center, care being taken that neither the point nor the hatchet be shifted while the paper is being turned. The line, A B, will again be roughly at right angles to the instrument, but in the reverse direction (see dotted lines in Fig. 3). Again cause the tracing-point to traverse the line, A B, and the boundary line as before, but this time in a contra-clockwise direction. The hatchet after this backward motion will take up the new position, X_1, which may or may not coincide with X; if not, prick a central point between X and X_1, as shown; then, of course, the distance of this point from Y is the mean side shift of the hatchet; this distance measured from the zero of the scale on the back of the instrument is the area of the figure in square inches. The scale is read in exactly the same manner as a geometrical scale on a drawing, the whole numbers being read to the right of the zero and the decimals to the left. The instrument does not profess to give results nearer than one-tenth of a square inch.

"When the figure is too large to be conveniently turned, the instrument itself must be turned through 180°, and two fresh dents, X^1 Y^1, obtained. The mean of the two readings, X Y, X^1 Y^1, will be the area sought.

"If, in large figures the instrument be out of square with A B at the finish, it is necessary to see that the mean position be square with A B. The scale is made with regular and increasing divisions, which compensate for errors that otherwise would have to be taken into account, and which add greatly to the labor of computing the area with exactness."

The relative accuracy of this planimeter, compared with Ammsler's, and with other methods, is exemplified in the following table:

Method.	Measurement of Areas Reduced to 100.
Amsler planimeter	100
Goodman "	100 + or — 0.6
Simpson's rule	100 + or — 1.0
Mean ordinates	100 + or — 2.4
Cutting out in cardboard and weighing against piece of known area	100 + or — 4.4
Equalizing curved edges by drawing straight lines along boundary and calculating by triangles	100 + or — 7.0

In the instrument for getting mean heights of figures, the length of the instrument between the hatchet and the pointer is variable. The length is set to the length of the diagram (see Fig. 2); it is then used in precisely the same manner as the planimeter described. The diagram in Fig. 5 will be clear. The mean distance between the dents is in this case the mean height of the diagram, measured on an

ordinary scale, or the mean pressure in the case of an indicator diagram measured on a scale to suit the indicator spring. The method of correcting the instrument by increasing divisions of the scale is approximately correct for all lengths of diagrams, the error being well under one per cent.

New Departure in Boat-Building.

THE manufacture of dwellings in such manner that their parts may be sent packed separately and assembled at the point of erection has been successfully carried on for a considerable period. A similar system, described in the *American Shipbuilder* (Oct. 8), has been applied to the manufacture of boats by a St. Louis boat-builder.

"When furnished with the size of boat that is desired, he gets out the material, fastenings, etc., all ready to put together, and ships them to the purchaser to build the boat with. The main object in supplying boat-building materials is the great amount of money saved in freight charges. For instance: the freight charges from St. Louis to San Francisco on a completed hull weighing 2,000 pounds would amount to $250, while the materials for the same hull (minus the planking), all cut and bent to exact proper shape, crated, would weigh 1,100 pounds, and would reach the same point at an expense of $11 for freight. The same shipment from St. Louis to New York would amount to $77.80 and $10.67 respectively, the eastern rates being higher than the western. This immense difference in charges of transportation allows the purchaser to build a hull under his own supervision for less money than the difference in freight charges. The only other advantage is that, in purchasing a frame, the buyer gets at the same time a model, which is the most important item in constructing a hull.

"The launch frames are said to be made entirely of best selected Arkansas white oak, and consist of keel and keelson all shaped up and spliced and fitted to bow-stem and sternpost. All holes for bolts bored; bow-stem babbeted to receive planking and fitted to keel; round stern transom cut from solid planks and fitted to stern-post; garboard and sheer strakes and all timbers (or ribs) steam bent to proper shape; every part of frame completely marked; the whole accompanied by a sheet of plain instructions, so that any one of ordinary ability can set the frame up ready for planking."

The enterprising builder of these boats will doubtless get an extensive patronage, but, having set the pace, he can hardly escape competition. The possibility he has discovered will soon draw others into the field.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

*8127. Six Examples of Successful Shop Management. Ill. Henry Roland (Showing in this instalment the conditions of labor employment in the Whitinsville shops). Serial. 1st part. Eng Mag-Oct. 4200 w.

*8165. Core Prints. Herbert Aughtie (How core prints ought to be made for different positions and uses). Prac Eng-Sept. 4. 1000 w.

8361. Tool Room Equipped from the Scrap Pile—Substitute for Chalk—Book of Blueprints—Belt Diagram. S. T. Freeland (Practical hints upon topics named in title). Am Mach-Sept. 24. 2000 w.

8364. Cabinets for Drawings. William H. Derbyshire (A design for cabinet, used in the works of Bement, Miles & Co). Am Mach-Sept. 24. 100 w.

8365. Tool Room Management (A paper read before the "Advance Club," Dayton, Ohio, by Joseph Kelly, assistant foreman of the tool room of the National Cash Register Co. Drawings for tools as usually made are criticised. Comment by editor of *American Machinist*). Am Mach-Sept. 24. 1000 w.

8366. How to Turn Out Good Molders. D. F. Matlack (Read at the Philadelphia meeting of the Am. Foundrymen's Assn. In apprentices, fitness, industry and intelligence should be rigorously recognized). Am Mach-Sept. 24. 700 w.

8367. Old and New Methods in Boiler Making (The methods of thirty years ago are contrasted with the improved methods of to-day, and some fine examples of marine boiler work are named and briefly described). Am Mach-Sept. 24. 2500 w.

8406. Charging Cupolas. E. Grindrod (A plain, practical talk by a practical man who has

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reasons to offer for each detail of practice). Foundry–Sept. 700 w.

8407. Cupola Practice. H. M. Ramp (Personal opinion based on experience. First part reviews recently published articles by leading foundry men). Foundry–Sept. Serial. 1st part. 1500 w.

8409. Compressed Air and its Economies in the Foundries. Curtis W. Shields (Full text of paper read before the Sept. meeting of the Western Foundrymen's Assn. The various applications of compressed air in foundry work and the advantages resulting are set forth). Foundry–Sept. 3300 w.

8410. Making Clean Castings (The necessary safeguards to prevent dirty castings are stated). Foundry–Sept. 800 w.

8557. Laying Out a Worm and Worm Gear. W. L. Cheney (The nature of a worm gear and the proper method of laying it out to secure satisfactory results). Mach–Oct. 2200 w.

8559. Machinists' Piece Work. M. S. Link (The piece work system, while admitted to place workmen in their highest working capacity, is condemned as gradually extinguishing the grade of good all-around machinists). Mach–Oct. 1500 w.

8639. Bevel Gear Curves. H. W. Alden (A table, or set of curves, to cover all ratios, with explanatory text). Am Mach–Oct. 8. 1000 w.

8640. A New Lathe Chuck. F. A. Halsey (Illustrated description of work done on a new chuck having a wide range of capacity, and designed by M. A. Sangster, foreman of the Canadian Rand Drill Co). Am Mach–Oct. 8. 800 w.

Steam Engineering.

8245. Caring for Steam Cylinders and Pistons. W. H. Wakeman (Practical hints derived from authority and experience). Safety V–Sept. 2800 w.

*8290. The "Universal" High-Speed Engine (Results of tests). Engng–Sept. 11. 1000 w.

*8322. The Raworth "Universal" Steam Engine (Illustrated description and an account of tests and results). Elect'n–Sept. 11. 700 w.

8391. The Most Economical Cut-off for Steam Compression. Henry T. Eddy (Abstract of a paper read before the Amer. Assn. for the Advancement of Science. The conclusion is reached that for maximum economy the cut-off must be such that the ratios of expansion and of compression shall be equal). Elec Wld–Sept. 26. 900 w.

8424. Effect of the Rate of Combustion Upon the Efficiency of Steam Boilers (Editorial review and critique of a paper read by Prof. W. F. M. Goss of Purdue University, before the New York Railroad Club. The paper is regarded as an important contribution to the literature of steam engineering, but exceptions are taken to some of the statements). Eng News–Sept. 24. 2800 w.

8457. State Inspection of Boilers in Massachusetts. From a paper by Thomas Hawley (A review of the Massachusetts law and how it is working). Bos Jour of Com–Sept. 26. 2400 w.

8519. Steam Boiler Practice in Europe (Extracts from the report of Mr. R. S. Hale, in Circular No. 5, of the Steam Users' Assn., on current European practice, based upon personal inspection). Eng News–Oct. 1. 3200 w.

†8540. On the Rate of Condensation in the Steam Jet. A. de Forest Palmer, Jr. (Illustrated description of apparatus, method employed, and results attained in an experimental investigation of the subject named). Am Jour of Sci–Oct. 2500 w.

8553. A Method of Determining the I. H. P. of an Engine Under Varying Load. W. H. Macgregor and R. T Kingsford (Investigation of the power required to operate an Otis electric elevator, with diagrams). Power–Oct. 1000 w.

8555. The Blowing Out of Boilers. W. A. Carlile (Proper purpose and methods of blowing out boilers). Mach–Oct. 1200 w.

8558. Friction Losses and Oiling Systems for Steam Engines. E. T. Adams (Losses of engine power through friction and reduction of these losses through methods described and illustrated). Mach–Oct. 2400 w.

8560. An English System of Forced Draft. James Vose (Illustrated description of the "Meldrum" dust fuel and forced draft furnace for steam boilers). Mach–Oct. 1400 w.

8583. Steam Making. Winthrop Thayer (Paper read at meeting of New England Cotton Mfrs. Assn. The writer gives his views of the essentials of economical steam making). Bos Jour of Com–Oct. 3. 3000 w.

†8584. Heat-Wastes in Steam-Engine Cylinders. Robert H. Thurston (Abstract of paper read before the British Inst. of Naval Architects at its session in 1895. A condensed statement of the theory of heat wastes in the steam engine cylinder). Jour Fr Inst–Oct. 6000 w.

8629.—$1.50. Description and Computation of Twenty-four Hour Duty Test on the Twenty Million Gallon Leavitt Pumping Engine at Chestnut Hill. Edward F. Miller (Illustrated description of engine with extensive tabulated data). Tech Quar–June–Sept. 6000 w.

8651. Indicator Practice. A. C. Lippincott (Illustrated dissertation of a practical character, dealing chiefly with reducing motion devices). Lord's Mag–Oct. 1200 w.

Miscellany.

8143. The Efficiency of Pelton Water-Wheels. F. K. Bloue (A method of finding deficiencies and faults in connections and settings which interfere with the normal efficiency of a Pelton wheel. Notation and formulæ employed and interpretation of results). Elec Wld–Sept. 12. 2500 w.

*8168. Steam Locomotion on Common Roads. W. Fletcher (Illustrated description of the lighter types of road locomotives, and a comparison of their merits with those of the larger traction engines). Eng, Lond–Sept. 4. 4200 w.

*8177. Table Mountain Wire Ropeway (Illustrated description). Engng–Sept. 4. 700 w.

*8183. Flax Scutching and Flax Hackling

Machinery. John Horner (Illustrated detailed description of machines used, their operation, and the processes to which the flax is subjected from the raw state till fitted for market as "dressed line"). Engng-Sept. 4. 5400 w.

8241. Smoke Prevention from a Mechanical Standpoint. C. H. Benjamin (General remarks upon existing methods). Can Eng-Sept. 1500 w.

8247. Credit for Shop Experience in Entrance Examinations (General editorial remarks upon the subject, with reference to previous editorials and to replies from seventeen technical schools in reply to a circular letter inquiring what their practice is with reference to this subject). Am Mach-Sept. 17. 1800 w.

8285. The Manufacture of Radiators. H. Hausen (Illustrated detailed description). Heat & Ven-Sept. 15. Serial. 1st part. 2200 w.

*8294. The Prytz Planimeter (Letters from H. Prytz, criticising some points in the planimeter as recently improved by Scott, and claiming that Scott is not the inventor of improvements claimed by him). Engng-Sept. 11. 1300 w.

8307. Steel Tubes. H. K. Landis (The use and strength of steel tubes, with brief description of process of making). Am Mfr & Ir Wld-Sept. 18. 900 w.

8357. The Compressed Air Power Plant at Jerome Park, N. Y. (Illustrated description). Com Air-Sept. 1400 w.

8370. Goodman's Hatchet Planimeters (Illustrated detailed description). Sci Am Sup-Sept. 26. 2000 w.

8373. Compressed Air as a Hoisting Power in the Foundry. George A. True (Read before the Western Foundrymen's Assn. Description of plant required for a foundry of thirty tons daily output,—details illustrated,—and a general review of the advantages of such an installment in foundry work). Ir Age-Sept. 24 3600 w.

*8401. The New Russian Patent Law (Statement of the principal provisions of the law). Mach, Lond-Sept. 15. 800 w.

*8414. The Motor, or Horseless Carriage. James Long (The first part deals with existing obstacles to the use of the horseless carriage in the United Kingdom. The series will present descriptions of the best types of motor carriages). Ind & Ir-Sept. 18. Serial. 1st part. 2000 w.

8434. Long-Distance Power Transmission (Brief illustrated description of one of the most important examples of power transmission yet undertaken. Power transmitted from Ogden, Utah, to Salt Lake City—six miles of water pipe and 36 miles of electric wire). Ry Age-Sept. 25. 1000 w.

*8458. The Horseless Carriage of the Future (Editorial. Problems connected with horseless carriages and their present status). Eng, Lond-Sept. 18. 1200 w.

*8461. The Moving Sidewalk Railway at the Berlin Industrial Exhibition, 1896 (Illustrated description). Eng, Lond-Sept. 18. 1500 w.

8498. Making Balls for Bearings Horace L. Arnold (Full, illustrated description of method and appliances). Am Mach-Oct. 1. 4500 w.

8500. Tacks and Tack Dies. J. L. Lucas (Illustrated description of the Blanchard tack machine, and the method of cutting tacks from sheet metal). Am Mach-Oct. 1. 700 w.

8520. Pneumatic vs. Iron Tires for Vehicles (Abstract of article in *Le Genie Civil.* Historical. Illustrated). Eng News-Oct. 1. 500 w.

8556. At the Worcester "Tech." (Illustrated description of mechanical engineering equipment). Mach-Oct. 600 w.

8563. Power Transmission. F. H. Underwood (A paper read before the Profile meeting of the New England Cotton Mfr. Assn. A general dissertation upon power transmission in a modern mill, say of 400,000 spindles, operated by steam power). Eng Rec-Oct. 3. 1000 w.

*8569. Quick-Firing Field Guns (Illustrated detailed description). Eng, Lond-Sept. 25. 2000 w.

*8570. Report of the Screw Gauge Committee of the British Association (Exhaustive, with a tabulated statement of screws recommended, and appendix with diagrams, and descriptions of shadow photographs of screws. Also appendix on gauges for verifying accuracy of screws, and another giving working dimensions in millimeters, and in thousandths of inches). Eng, Lond-Sept. 25. 3000 w.

*8572. Address to the Mechanical Science Section of the British Association. Douglas Fox (Review of mechanical progress in the leading industries of the world, and in various branches of engineering). Eng, Lond-Sept. 25. 9800 w.

†8586. Niagara on Tap. T. Commerford Martin (Illustrated description and general remarks upon the utilization of the power of Niagara Falls by the conversion of the energy of its fall into electricity). Jour Fr Inst-Oct. 4500 w.

8623. Power Transmission by Vertical Shafts in a High Building (Illustrated description of power transmission by means of vertical shafts extending from the basement to the top floor). Ir Age-Oct. 8. 700 w.

8631.—$1.50. Tests on Bolted Joints (Illustrated description of eight tests made in the laboratory of the Massachusetts Institute of Technology, with tabulated data). Tech Quar-June-Sept. 1800 w.

8637.—$1.50. Torsion Machine, and Tests of Torsion (Description of a new measuring apparatus applied to the torsion machine of the Mass. Inst. of Tech., and tabulated torsion data for a variety of materials). Tech Quar-June-Sept. 3500 w.

8638.—$1.50. Rope Tests (Tabulated data obtained in the laboratory of the Mass. Inst. of Tech., with a variety of ropes and splices). Tech Quar-June-Sept. 250 w.

8644. Gray Iron Work and Malleable (From the *Iron Molder's Journal.* Some difficulties encountered by those who go from the gray iron into general jobbing on malleable iron, with suggestions as to best method of disposing of them). Ir Tr Rev-Oct. 8. 1000 w.

MINING & METALLURGY

Carelessness and Mining Accideuts.

In reviewing the record of casualties for 1895 in the Pennsylvania mines, *The Colliery Engineer and Metal Miner* finds "the usual proportion of fatal accidents largely attributable to the recklessness or carelessness" of the victims. It admits that this is "rather a harsh criticism to make on the poor fellows who lose their lives in the coal mines, but it must be made, and the dangers must be pointed out, if a remedy is to be secured."

To establish the case as alleged against the miners, quotations are made from the reports of the inspectors in many districts, both in the anthracite and bituminous fields.

"Mr. Edward Roderick, inspector of the first anthracite district, in commenting on the one hundred and sixty accidents (fatal and non-fatal) that occurred in his district, says that seventy-six were caused by falls of coal and rock. Some of the deaths caused by falls were, he states, undoubtedly purely accidental, but the greater number of them were the results of direct or indirect recklessness, as is proven by an examination of his detailed report. The number of men who were killed during the year by going under a portion of roof which they had been trying to pull down just a few minutes previous to its falling is remarkable.

"These accidents cannot, at all times, be attributed to the ignorance of the victim, for in many cases during the year intelligent miners have been killed in this way. Oftentimes, after firing a shot, men go back to the face of their working-place, sound the roof, and find it somewhat loose. As they say, 'It is not loose enough to fall yet, and we will keep an eye on it.' With this remark they proceed to work in the face, when it is their imperative duty to first secure the roof. So long as men continue to work in this careless and thoughtless manner under dangerous and loose pieces of roof, just so long will the record of these accidents occur.

"In commenting on mine accidents in his district, Mr. G. M. Williams, of the fourth district, says: 'It has been repeatedly stated that most of the mine accidents take place owing to the carelessness of the victims, and thus an impression has been created that the underground workers are less careful than employees in other industries. The assertion that the greater number of the mine accidents are due to carelessness is certainly correct, but it is not fair to say that the mine workers are more careless than men generally are in proximity to danger.'

"Mr. William Stein, of the sixth anthracite district, is of the opinion that mine accidents under present systems of working can be reduced at least eighty per cent. He calls attention to the fact that, of the fifty-six fatal accidents in his district in 1895, forty-seven were due either to carelessness or a lack of knowledge as to the safety of working-places; three lost their lives through the neglect of a fire boss in allowing the victims to enter their place of work before first removing the gas; the remaining nine accidents he considered purely accidental. Forty-seven who lost their lives chose themselves to take unusual risks while in the performance of a day's work, and their reasons for so doing can only be presumed.

"Mr. William Jenkins, of the second bituminous district, says: After careful investigation of all the fatal accidents, I find that fourteen men were killed from carelessness on their own part.'

"Mr. Thomas K. Adams, of the third bituminous district, reports but seven fatalities in his district during the year, but of these seven he states that at least two resulted from gross carelessness. Both of the victims had been warned of their danger just previous to the accidents which killed them; both had been warned of the dangerous condition of the top and advised how to proceed; but in both instances the friendly counsel was not heeded.

"Mr. Charles Connor, of the fifth bitu-

minous district, in commenting on the accidents in his district, says: 'It is an unpleasant duty to have to report year after year the same old story,—that a large number of the accidents were the result of carelessness either on the part of the injured parties themselves, or of some other person,—and yet this is too true. Seven of the thirteen persons who were killed during the year would have been alive today if they had exercised even ordinary care to protect their lives, while two of them met their death through the carelessness of others; thus only four of the fatalities can be properly said to have been accidental, the others being the result of contributory negligence, either by themselves or others.'

"Mr. James Blick, of the seventh bituminous district, says: 'Of the whole number of deaths from falls of slate (12), only about five can be classed as purely accidental; five others could have saved themselves if they had exercised proper care; and at least two came to their death because they were not familiar with the methods of self-protection.'

"Mr. Joseph Knapper, inspector of the eighth bituminous district, says: 'In the reports of accidents, both fatal and non-fatal, there are shown several cases of gross carelessness, whereby the victims exposed themselves to falls of coal and roof when they knew that danger existed.'

"Mr. Bernard Callaghan, of the ninth bituminous district, commenting on the accidents in his district, says: 'Some of the accidents were remarkable, while some were the direct results of neglect. The greater number of the miners killed were Americans or other English-speaking people, so that ignorance of the language and of the mining laws cannot be blamed for their unfortunate end. The only advice that can be given is a caution for constant care and faithful observance of the mining laws. When men learn to value their lives more than the price of a wagon of coal, the mine will have lost its death-record.'

"Mr. R. Hampson, of the tenth bituminous district, in commenting on the accidents in his district, says: 'The number of fatal accidents is much greater than that of the preceding year, and, on examining into the causes of them, it was found that four of them were attributable to falls of coal and roof, and those killed by falls of coal had neglected, in each instance, to set sprags while undermining coal, and in two of the cases the coal had already been loosened by a previous shot, and in the other there was a slip running through the coal to the roof, while, in the case of the man killed by fall of roof, he was negligent even to foolhardiness, for he was repeatedly warned by his fellow-workmen to come out of the place until the roof had settled, but he told them "he knew when it was dangerous, and when to come out." It is sad to reflect on the above accidents, which in every case could have been averted, had each one taken the necessary precaution for his safety, and obeyed the rules laid down for his guidance, for it is only by following out the rules that such accidents can be averted.'"

It is from Mr. Hampson's suggestions (which are echoed by many of the other inspectors) that *The Colliery Engineer* takes the text for its preachment.

"It is evident from the above that a rigidly-enforced discipline is necessary in the coal mines of Pennsylvania. With our jury system it is almost impossible for a mine inspector to secure the conviction of a working miner who violates the mine laws. There are two reasons for this; one is that the violator of the law is frequently the victim of the accident, and, if not killed, is severely injured, so that all classes of the community consider him sufficiently punished for his carelessness and disobedience of the law. Another reason is that the average jury does not understand the technicalities of mining, and they sympathize with the poor unfortunate who has been prosecuted for disobeying what to them seems a trivial provision in the mine law. This and sympathy for the miner result in his immunity from punishment.

"If, under our constitution, it was possible for the mine inspector to order the arrest of a miner caught violating the law,

have him taken before a justice of the peace and fined or imprisoned, the law could be better enforced, but, under the constitution of Pennsylvania and the various mining States of the union, such a procedure would be illegal, as every man has a right to trial by jury."

This *is* unfortunate; but, as the *Colliery Engineer* says just above, the offence often becomes apparent only through the death of the offender, and, after that event, even denial of the right to a jury trial has little terror for him.

It is unfortunately but too probable that Mr. Callaghan comes nearer to the heart of the matter,—"the price of a wagon of coal." Under the tonnage system of payment which prevails throughout the region, nothing but merchantable coal at the tipple means any money to the miner.

Suspension of shipping facilities and developments of the operators' policy make the duration of work very uncertain; few have claimed that the rates of payment are highly remunerative at the best.

Is it any wonder that every wagon of coal is coveted, and important, but profitless, work neglected on the chance that all will go right, and a few more tons of the wage-bringing coal be placed to the miner's credit instead.

No doubt the men are often criminally reckless; no doubt, like other workers in dangerous occupations. Many of them would take needless risks under any system, unless restrained by a strong hand; but, when the same story comes with so terrible similarity from all over the field, it suggests a more general and deeper-lying cause.

"The price of a wagon of coal" means too much. It is possible (with all deference to *The Colliery Engineer* in the proposal of a remedy) that "intelligent miners" who "knew that danger existed" and still took the chance of death for a slight increase of earnings might still take the chances of the law, jury or no jury, under the same pressure.

Poverty is a strong tempter. A sort of desperation is generated by want, which creates indifference to personal risk, and has sacrificed many lives.

Free Coinage—and What Next?

IN Mr. Tait's excellent article on the silver question, in the September number of THE ENGINEERING MAGAZINE, occurred the significant words: "There has been no talk, up to the present time, of issuing certificates against the deposits for coinage."

The expression recognized a possibility which Mr. Tait, no doubt properly, considered it premature to consider in a criticism of the present position and demands of the free-silver party; but that this would be the next step is beyond all question, and the course is already being conjectured by the press and its bearings considered.

The situation is thus outlined by the *American Manufacturer:*

"The superintendent of the Philadelphia mint has made an important statement to the effect that, if a free-silver-coinage law should be enacted at this time, it could not be enforced. He points out that it would be a physical impossibility for the government to coin the silver which, under the provisions of such a law, would be dumped into the mints. The government vaults now contain 200,000,000 ounces of silver bullion, and, at the present minting capacity, it would require five or more years to coin this into money before an ounce of the bullion which would be poured in under a free-silver law could be touched. The superintendent claims that ten years would be required to increase the capacity of the mint, during which time bullion would be accumulating in such quantities that the mints would never be able to use it up. The answer of the average silverite may be anticipated. He wants the government to provide storage for vast accumulations of bullion, and then issue silver certificates to the coinage value of the bullion, at a ratio of sixteen to one. Really he does not want silver at all. In fact, he would rather not have it. He wants paper."

There is no kind of question that this defines correctly the future attitude of the vast majority, at least, of the silverites, should their primary demand for free coinage prevail. The inflationists who are possessed by the conception that prosperity is contingent upon the volume of

currency—an idea about as logical as the assumption that the wheat market depends on the number of bushel measures in the country—will naturally proceed to inflate the volume as rapidly as possible, so as to "hasten the dawn of prosperity." The silver owners who are seeking an unlimited market will rebel at the limitations which would be enforced by the delays of coinage, unless, indeed, a few of the wiser ones should share, with the same element of the community, the perception that the invited deluge would utterly break down the market and overwhelm them, with the country at large, in the river of a demoralized and discredited currency.

More Cyanid Litigation Threatened.

THE cyanid patents, which Dr. Wells's able article in the August number of THE ENGINEERING MAGAZINE showed to have so little claim for protection in the light of the plain testimony of history and experiment, appear to be having a hard struggle to establish their validity the entire world around.

The settlements reached in this country are understood to be wholly of the nature of a compromise, and, until the case has been fully presented and decided by the higher courts, the claimants' contention must be considered at least "not proven."

The following clippings from the *Australian Mining Standard* show that the agitation is beginning at the antipodes, and that the patentees are likely to have a rough road to travel before the validity of their rights will be unquestioningly recognized by the mining world.

The cyanid process has been the subject of questioning in the New South Wales assembly. The Hon. Sydney Smith, minister for mines, in answer to Mr. Willis, said that he was aware that certain persons in New South Wales claimed to hold a patent right for working what was known in mining as the "cyanid process" of recovering gold from ores. He understood that a heavy royalty was being demanded for treating ores or tailings by this process, and it was a fact that these persons held such patent rights, but the question as to whether they could enforce royalty under these patent rights had not been tested in the colony; probably it will soon be tested. Cyanid has done for gold-mining what it is hoped the sulphid processes will do for silver. Any restrictions on its use are pretty certain to be challenged.

A correspondent from New Zealand writes, with reference to the cyanid process, that that government has written to the Victorian government for reports of the arguments which defeated the Cassel Company's application for an amended patent. These arguments will be used by the government in the counter action to the company's application in the New Zealand court for an amendment of the patent. In the event of the application not being granted, the company will carry the case to the privy council.

Sundry Views of the Tin-Plate Industry.

THERE was a time, not very long ago, when a casual reader of the daily press might easily have received the impression that the future of the American people was bound up in the manufacture of tin plate. The dinner-pail threatened to divide the nation. According to some, the national honor was dragged in the dust with every importation of English tin; according to others, it was sheer fatuity to contemplate the establishment of the industry in this country.

But we have begun to make tin; the sun still rises and sets in the accustomed quarters; and the net result is so unapparent that the press has almost forgotten the discussion, and the mention of tin plate awakens only a fleeting reminiscence.

The lapse of time has been sufficient for the situation to have become pretty clearly defined. It may, therefore, be interesting to compare an English and an American view of the present status of affairs.

The *American Manufacturer* says: "The latest figures on the British tin-plate exports show that there were 13,930 tons of tin plate brought into the United States during the month of July. This is the largest monthly amount reported for this year, exceeding that of the previous month by 2,177 tons, or an increase of

about 19 per cent. Compared with July of the preceding year, the figures show a decrease in the exportations of about 12 per cent.

"This marked increase in the amount of tin plate brought into our country from Great Britain is largely to be accounted for by the reduction in the labor cost of manufacture in the Welsh tin-plate districts, from which the greater part of the British tin plate comes. Some time ago the Welsh manufacturers, realizing the fact that their American trade was fast slipping from them, decided to make some decisive move. In conjunction with the workers some considerably reduced the cost of production, and shipped their tin plate at lower figures than ever. In some parts of the trade, however, a strike is threatened, and next month may show lower exports. The tin-plate trade just now, as it has for some time past, is a striking illustration of what the foreign producer can do to hold back an American industry. The prices at which Welsh tin plate is now laid down in New York are extremely low, but with inadequate protection they must be met by American producers."

According to the (British *Iron and Coal Trades Review*, however, "there is a general impression abroad that the tin plate industry of Great Britain is doomed to suffer a curtailment that will lead to the closing of many mills, and to the deprivation of employment over a large area of labor. We have from time to time pointed out that, so far as the United States are concerned, this has now become almost a foregone conclusion. The tin-plate manufacturers of South Wales, some of whom looked at the matter with a light heart when the McKinley act gave the Americans the chance for which they had long been watching and waiting, are ready to admit so much themselves. Not only so, but they also admit that the Americans have to a certain extent improved the details of the manufacture, and are now in some respects doing actually better work than is being done in South Wales. This is certainly a remarkable change, when we look back upon the conditions that prevailed six years ago, when South Wales had the tin-plate industry almost wholly to herself, and when the Americans were almost ridiculed for supposing that it was within their power to make any progress with an industry that had up to that time been ignorantly and foolishly regarded as a Welsh monopoly.

"Thoughtful men in the trade are now most anxious about its future. Some look upon Canada as likely to expand steadily, and great hopes are entertained of what may be done in British Columbia, but it is important to bear in mind that the Canadian market has already been captured to a large extent by the United States, and that the same result is likely to happen in reference to tin plates. The hope of the trade lies in the east. If the Welsh manufacturers are wise in time, they will send out competent commissioners to look out new markets and press their wares more energetically upon old ones. Thus, and thus only, can they 'hold the fort' in the future."

It is noticeable that the tone on both sides is strongly discouraging—even pessimistic. Looking at the matter broadly, it seems a very imperfect success to have established an unprofitable industry here at the expense of destroying a prosperous one abroad. The greatest good to the greatest number does not seem to have been subserved in this instance. And it is significant that the *American Manufacturer* follows a somewhat familiar precedent in suggesting, as a remedy for the home industry, more protection.

Meanwhile, it will interest all parties to learn of any promised addition to the world's store of tin. The *Australian Mining Standard*, commenting upon recent developments in South Gippsland, says of the "Great Southern tin mine":

"The prospects promise to be highly remunerative, and bid fair to remove the prejudice that Victoria is not a tin-producing country. The Great Southern tin mine is an English proprietary company, and the shares are well held. Nearly the whole of the capital was subscribed in London and France, only a few shares being allotted in Melbourne to persons

who had interested themselves in the industry, and were desirous of participating in the development of the field."

The Herring-Bone Method of Timbering.

AN article in *The Colliery Guardian* on "The Economical Use of Timber in Mines" contains many excellent hints, both as to methods and means.

A number of the suggestions are applicable chiefly to English practice. The "larger opportunity for greater economy" afforded to mine managers in the possibility of recovering timber from abandoned workings, for instance, is hardly realizable in this country, as yet; for our mines are generally situated in regions where timber is cheaper than labor, and we have not developed the far-sighted economy of forest-preservation.

It is significant of the different conditions prevailing in England that about half of the paper is devoted to criticism of wasteful practice, and suggestions of measures for preserving or recovering timber.

Some excellent advice is given as to the handling of heavy sticks by simple mechanical aids, procurable in any mine; the most interesting part to American miners, however, is the exposition of the "herring-bone method" of timbering, adaptable to any situation where the roof weights particularly in the middle.

"In such places," says the writer, "the ordinary transverse timber has a very short life, owing to the concentrated load it carries."

Left to themselves, such roads "arch themselves" and the "herring-bone" method takes advantage of this circumstance. Any other method is more costly and less reliable, for, whatever the method employed, the roof will assume more or less of this arch form. When the timbering is of the usual transverse kind, the concentrated weight on the middle necessitates its constant renewal, and the middle of the roof continually works itself out. Under such circumstances, the renewal of this transverse timber may be performed in one of three ways. First, the new balk may be put exactly where the old one has come out. The middle of the roof being fallen, such a balk will get a hold at each end only, and other timber must be superposed to support the middle. This superposed timber again transmits the load to the middle of the beam, besides which the over-hanging sides, being either imperfectly supported or wholly unsupported, are dangerously liable to fall away and cause disaster. Or, secondly, having put in the new balks at the level of the old ones, the whole can be lofted with running battens. This will be safer, because the lofting will catch the overhanging sides when they fall; a natural pack will thus be put on the top of the lofting, and the load will be better distributed on the main beam. But such a method entails a very extravagant use of timber, and is still more expensive to repair. Or, thirdly, we can remove the overhanging sides, and raise the new balk to the level of the roof. This makes the best of the three; but the removal of the sides is a costly work, besides possessing the additional disadvantage of again giving the middle roof full liberty to concentrate the load at the middle of the beam, and so recommence the whole difficulty. The only satisfactory course is that most seldom taken. It is to adopt the "herring-bone" method. By this method, and supposing the roof to have "arched itself," the main timber is not to be put in transversely, but longitudinally. A long balk of round timber (which need not be too heavy) is run longitudinally in the middle, where the roof is the highest, and temporarily supported on vertical props. Under the hanging sides places are dressed to receive side struts, whose other ends are carried to the longitudinal beam, which may, if thought necessary, be shaped to receive them firmly. The struts and balk being firmly wedged in position, the temporary props are removed. A length of timber thus arranged looks much like the interior view of a gabled roof, and is, in fact, sometimes called Gothic timbering. In the circumstances named, the economical value of this style of timbering can scarcely be over-estimated. The expense of taking down the overhanging sides is saved, these being securely timbered by

the struts; and the sides thus left on have considerable influence in supporting the middle roof. The main timber supporting the heavy middle roof, being run longitudinally, receives a distributed, instead of a concentrated, load, and, further, being supported by numerous struts, has no long span, such as is necessary when the usual transverse method is employed. Shorter and cheaper timber may be used for the struts, and, finally, the strength of the whole arrangement is much greater, the renewals are much rarer, and the safety much more pronounced, than under the transverse system hitherto widely used, but altogether inferior.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

Metallurgy.

*8194. The Iron and Steel Industry of Spain. Pablo de Alzola (Some information regarding the iron ore deposits and the importance of the workings, with consideration of the iron and steel industry). Col Guard–Sept. 4. 6300 w.

*8195. Modern Blast Furnaces and Production of Iron in Various Countries Translated from a continued article in *La Métallurgie* (The first part deals with the subject as related to the United States, Germany and Luxemburg). Col Guard–Sept. 4. 2200 w.

*8198. A Note on the Missing Carbon. T. W. Hogg (What the term "missing carbon" means, as used by H. M. Howe in a recent paper, with investigations showing that the carbon concerned is capable of exact measurement). Ir & Coal Trds Rev–Sept. 4. 1200 w.

*8199. The Roasting of Iron Ores, with the View to their Magnetic Concentration. H. Wedding (Extracts from paper discussing the influence of roasting on the reducibility of iron ores, and for subsequent magnetic treatment with other interesting matter). Ir & Coal Trds Rev–Sept. 4. 3300 w.

*8200. Sand on Pig-Iron and Its Avoidance. H. D. Hibbard (Describes apparatus for casting pig-iron, claiming a saving in cost and labor). Ir & Coal Trds Rev–Sept. 4. 2000 w.

†8213. The Magnetic Separation of Non-Magnetic Material. H. A. J. Wilkens and H. B. C. Nitze (The object of the paper is to set forth the substance of previous statements, made orally at the Atlanta and Pittsburg meetings of A. I. M. E., embodying therewith additional information gained since that time, and a brief illustrated description of the method and means of the separation). Trans Am Inst of Min Engs–Sept. 8400 w.

†8215. Laboratory-Tests in Connection with the Extraction of Gold from Ores by the Cyanide Process. H. Van F. Furman (Description of the latest laboratory methods. How to determine the adaptability of an ore to this method of treatment). Trans Am Inst of Min Engs–Sept. 5300 w.

†8217. The Concentration of Ores in the Butte District, Montana. Charles W. Goodale (A study of the treatment of these ores, which present a variety of combinations, with historical account of plants erected in the Butte district). Trans Am Inst of Min Engs–Sept. 16000 w.

†8221. The Bertrand-Thiel Open Hearth Process. Joseph Hartshorne (Describes a new development of the open hearth process which the inventors claim has increased the product per furnace, reduced the amount of refractories and additions used, enabled a poorer and more varied quality of stock to be employed, improved the quality of the material produced and rendered the control of the operations and product more certain). Trans Am Inst of Min Engs–Sept. 2000 w.

†8222. The Actual Accuracy of Chemical Analysis. F. P. Dewey (Compares the results obtained by several chemists, working upon the same sample and by various methods). Trans Am Inst of Min Engs–Sept. 3500 w.

†8223. The Occurrence and Behavior of Tellurium in Gold-Ores, More Particularly with Reference to the Potsdam Ores of the Black Hills, South Dakota. Frank Clemes Smith (Results obtained in the study of the refractory gold-ores of the Potsdam sandstone. Illustrations). Trans Am Inst of Min Engs–Sept. 6000 w.

†8225. The Microstructure of Steel and the Current Theories of Hardening. Albert Sauveur (Describes at some length the changes of microstructure which occur, during slow cooling, in steels containing various amounts of carbon, and examines what bearing, if any, such structural changes as occur at the critical points, have upon the current theories of hardening). Trans Am Inst of Min Engs–Sept. 14000 w.

†8226. Silver-Losses in Cupellation. L. D. Godshall (Treats of the losses sustained by silver, under certain specified conditions, during the process of cupellation, and the conditions which govern these losses). Trans Am Inst of Min Engs–Sept. 1400 w. and table of results.

†8227. The Cyanide-Process in the United States. George A. Packard (Data giving an idea of the development of the process and of the methods followed in the principal mills). Trans Am Inst of Min Engs–Sept. 3000 w.

†8229. A Modern Silver-Lead Smelting-Plant. L. S. Austin (Describes a plant whose site is assumed to possess natural advantages which are utilized to their full extent). Trans Am Inst of Min Engs–Sept. 5400 w.

We supply copies of these articles. See introductory.

8240. Aluminum. J. B. (Some of its characteristics). Can Eng-Sept. 900 w.

8248. Testing Metals for Hardness. A. Föppl, in *Contralblatt der Bauverwaltung.* (From *Iron and Coal Trades' Review.* A method of ascertaining the hardness). Am Mach-Sept. 17. 600 w.

*8312. Close-Sizing before Jigging. Robert H. Richards (Experiments undertaken by the author for the purpose of investigating to what extent equal sized particles, interstitial currents, acceleration and suction bear on the results). Eng, Lond-Sept. 11. 900 w.

8343. The Anaconda Electrolytic Copper Refinery (Illustrated description). Eng & Min Jour-Sept. 19. 4000 w.

*8344. A Note on the Presence of Fixed Nitrogen in Steel. F. W. Harbord and T. Twynam (Read at meeting of the Iron & Steel Inst. Investigations of authors, without conclusions being drawn). Ir & St Trds Jour-Sept. 12. 800 w.

*8345. The Present Position of the Iron Ore Industries of Biscay and Santander. William Gill (Part first relates to the province of Biscay and treats of the deposits, mines, working, transport and shipping, concentration and calcination). Ir & Coal Trds Rev-Sept. 11. Serial. 1st part. 3300 w.

*8346. The Estimation of Sulphur in Iron Ores. R. W. Atkinson and A. J. Atkinson (Description of method of analysis which gives very satisfactory results). Ir & Coal Trds Rev-Sept. 11. 1000 w.

*8347. The Le Chatelier-Heräus Thermo-Pyrometer. Dr. H. Wedding (Translated from *Stahl und Eisen.* Steps that led to its construction, and directions for use). Ir & Coal Trds Rev-Sept. 11. 800 w.

8408. Aluminum Bronze and its Uses in the Arts. From the *Aluminum World* (Defines term, gives discovery, valuable qualities, uses, strength, etc.). Foundry-Sept. 2300 w.

8441. The Manufacture of Wrought Iron. James Kerr (Paper read before the West of Scotland Iron & Steel Inst. Describes the conditions of the puddler and the puddling process as they were twenty-five years ago and as they are to-day). Ry Rev-Sept. 26. 1800 w.

8470. The Engelhardt Bromine Gold Extraction Process in Operation. D. C. Pret and H. Trachsler (Description of the successful treatment of tellurium ores at the bromination works of Pret, Trachsler & Co., at La Plata, Colo.). Eng & Min Jour-Sept. 26. 1400 w.

*8485. The Melbourne Mint (Description of the melting house, assay department, refining, and coining department). Aust Min Stand-Aug. 27. 3000 w.

8530. Improved Processes for Reducing and Saving Precious Metals. Alfred von der Ropp (Shows some of the new ways and means by which gold mining in the present is made profitable. Also calls attention to the superiority of American metallurgists and mining engineers). Min & Sci Pr-Sept. 26. 1900 w.

8532. The Cyanide Process at the Utica Mine. Thomas N. Smith (The process is limited to the slimes saved at the canvas plant. The work is explained, and a statement given showing results). Min & Sci Pr-Oct. 1. 700 w.

†8541. On the Estimation of Cadmium as the Oxide. Philip E. Browning and Louis C. Jones (Contribution from the Kent Chemical Laboratory of Yale Univ. The work described shows that when the carbonate is filtered upon an asbestos felt previously ignited the dangers of reduction are obviated and the carbonate process is simplified. The results are tabulated). Am Jour of Sci-Oct. 700 w.

†8543. The Action of Ferric Chloride on Metallic Gold. Parker C. McIlhiney (Experiments the result of which help to account for the solubility of gold in mine waters and in other waters containing iron, acid and common salt). Am Jour of Sci-Oct. 600 w.

*8592. Serrages (Obstructions) in Blast Furnaces. E. Bernard (Translated from *Revue Universelle des Mines, etc.* Information relating to obstructions in the body of the furnace). Col Guard-Sept. 25. 1100 w.

8594. The Transmutation of Silver into Gold (Correspondence from Von Schulz & Low, and F. M. Endlich in relation to this subject and Dr. Emmen's alleged discovery of "argentaurum"). Eng & Min Jour-Oct. 3. 2300 w.

8596. The Reduction Plant for Pyritic Gold-Bearing Ores, at Gibbonsville, Idaho. Bernard MacDonald (A brief description of the mines is given, followed by description of plant which has proved a success). Eng & Min Jour-Oct. 3. 2000 w.

8597. The Preparation of Alumina from Bauxite. James Sutherland (Description of the processes used by the British Aluminum Co., at the Larne Harbor works in Ireland). Eng & Min Jour-Oct. 3. 2200 w.

*8610. An Auxiliary Assay Balance. Robert Law (Read before the Chemical Society. Description of a new form of balance, which has been designed to meet a want felt by the writer when weighing the cornets obtained when pursuing the ordinary routine of gold bullion assay). Ind & Ir-Sept. 25. 1200 w.

*8611. The Metallurgy of Gold. C. C. Longridge (Patents of 1896, with notes). Min Jour-Sept. 26. 1800 w.

8624 The Gates Canvas Plant. W. S. Hutchinson (Description of plant and methods used at the Kennedy mill, near Jackson, Amador Co., Cal. The Gates methods are said to be adapted to any mill tails when their value is contained in the form of fine, rich, heavy material which escapes other methods of concentration). Min & Sci Pr-Oct. 3. 1300 w.

8636.—$1.50. Tension Tests (Tabulated data for iron and steel obtained in laboratory of Mass. Inst. of Tech.) Tech Quar-June-Sept. 2500 w.

8645. Varying Costs of Open-Hearth Steel (Extract from new work by H. H. Campbell. On open-hearth costs). Ir Tr Rev-Oct. 8. 1500 w.

We supply copies of these articles. See introductory.

Mining.

*8128. The Phosphate-Rock Deposits of Tennessee. Ill. Lucius P. Brown (Showing the extent, character and methods of phosphate mining in Tennessee). Eng Mag–Oct. 4500 w.

8191. The Great Mother Lode of California. Harold W. Fairbanks (Abstract of a lecture delivered before the San Francisco Gold Mining Exchange (Explains the meaning of the term mother lode, and describes its features). Eng & Min Jour–Sept. 12. 2500 w.

*8192. Atmospheric Influences on Magnetic Survey of Mines. H. W. Halbaum (Recounts a remarkable experience that can only be explained by the theory of atmospheric influence). Col Guard–Sept. 4. 4000 w.

*8197. The Manganese Ore Deposits of Northern Spain, with Notes on Some Other Sources of Supply. Jeremiah Head (Extract from a paper giving particulars of a journey made four years ago in Northern Spain. Tabulated cost of working at the Asturiana mine and results of analysis of the ores; with interesting information). Ir & Coal Trds Rev–Sept. 4. 1800 w.

†8214. The Smuggler Union Mines, Telluride, Colorado. J. A. Porter (Data relative to this property and the treatment of its ores is given). Trans Am Inst of Min Engs–Sept. 2500 w.

†8216. Electric Mining in the Rocky Mountain Region. Irving Hale (States advantages of electric power, describes systems, gives history, illustrates and describes machinery and gives list of electric-power plants for mines, mills and melters in this region). Trans Am Inst of Min Engs–Sept. 5800 w.

†8218. Additions to the Power-Plant of the Standard Consolidated Mining Company. Robert Gilmore Brown (Describes additions completed during the last year, interesting because of the engineering features involved and of the attainment of a high degree of flexibility with the two-wire, alternating system of electrical transmission). Trans Am Inst of Min Engs–Sept. 4500 w.

†8219. Sketch of a Portion of the Gunnison Gold Belt, Including the Vulcan and Mammoth Chimney Mines. Arthur Lakes (Describes the area extending from the Cebolla River on the west to the head of Taylor Park and the Sawatch range on the east). Trans Am Inst of Min Engs–Sept. 3000 w.

†8220. Further Notes on the Alabama and Georgia Gold-Fields. William M. Brewer (Investigations made during the winter and spring of 1896, lead to additional facts and opinions since paper presented in Oct., 1895). Trans Am Inst of Min Engs–Oct. 3500 w.

†8224. Note on a Shaft Fire and Its Lesson. Robert Gilman Brown (The fire described occurred in the shaft of the Standard mine at Bodie, Cal). Trans Am Inst of Min Engs–Sept. 1300 w.

†8228. Gold in the Guyanas. Henry G. Granger (Memories and impressions of a year spent in visiting its principal mining properties). Trans Am Inst of Min Engs–Sept. 4400 w.

*8250. The Leith Mine. H. L. Auchmuty (A description of a modern mine and coke works in the Connellsville region. The geological features of the tract worked, the system of mining employed, and the method of timbering, ventilating and drainage, together with a description of the surface improvements). Col Eng–Sept. 7600 w.

*8251. Cripple Creek. Arthur Lakes (The changes and improvements which have taken place within the past year. A description of the building of the new city and the continued remarkable development of the mining industry in the vicinity). Col Eng–Sept. 2600 w.

*8252. Pike's Peak. Arthur Lakes (Its geological formation and the reason why the ore veins are few and poor). Col Eng–Sept. 1800 w.

*8254. Zinc Mining. H. K. Landis (A description of the methods of mining and dressing zinc ores at Friedensville, Pa.; together with a history of their discovery and development, and an account of the early difficulties met with in treating the ores). Col Eng–Sept. 1500 w.

*8255. Mine Ventilation. J. T. Beard (A study of the equivalent orifice method as applied to the measurement of the yield of fans. A general review of the method and of the development of the equations upon which it is based, showing that they are founded on an error). Col Eng–Sept. 4500 w.

8308. Copper Mines of Michigan. Dr. Richard Moldenke (Extract from a paper read before the convention of German-American Engineers. The location of mines, method of working, and methods of concentration). Am Mfr & Ir Wld–Sept. 18. 1800 w.

†8352. Gold Deposits in Nicaragua (An account of the explored portion of Nicaragua, with information from Mr. Courtenay De Kalb and O. O. Hill and from official sources). Cons Repts–Sept. 3800 w.

8402. Trail Creek Mining District (Notes taken from the report recently made to the Provincial Bureau of Mines, by William A. Carlyle. The history, ore deposits, ores, and their treatment). Min & Sci Pr–Sept. 19. 2800 w.

*8415. The Phenomena of Colliery Explosions. Donald M. D. Stewart (A paper read at the meeting of the Federated Institution of Mining Engineers at Cardiff. Account of investigations of the disasters at the Camerton and Timsbury collieries—two explosions not complicated by the presence of fire-damp). Ind & Ir–Sept. 18. 2000 w.

*8463. Mining in New Zealand. A. J. Cadman (A statement by the minister of mines, of the important features of the past year's mining). Min Jour–Sept. 19. Serial. 1st part. 2800 w.

*8465. The Leicestershire Coalfield (Description of Ibstock colliery. Two plants are in operation, and the method of working, underground haulage, underground pumps, boilers, winding, screwing, etc., are described). Col Guard–Sept. 18. 2400 w.

*8467. The Transvaal Coal Deposits. Extract from the London *Times* (Particulars of the mineral resources of the Transvaal). Col Guard–Sept. 18. 1300 w.

*8468. Hoisting from Deep Shafts. Walter McDermott (Read before the Inst. of Mining and Metallurgy. An illustration of a system of winding known as the Whiting hoist). Col Guard–Sept. 18. 900 w.

†8486. Nevada Silver. Charles Howard Shinn (An interesting account of the discovery of silver in Nevada, the history of the great Comstock lode, the methods of reducing the ore, and facts connected with the industry). Pop Sci M–Oct. 8000 w.

8531. Gold Mining in California. Aug. J. Bowie (The benefits to the government from the gold mines of the country. Also interesting information on hydraulic mining, legitimate and speculative mining, speculative mines, mining as a business proposition, with an outline of the topography and geology of California, gold quartz veins, depth of mines, etc). Min & Sci Pr–Sept. 26. Serial. 1st part. 3300 w.

*8590. Turquoise Mining in Persia (Particulars respecting the celebrated turquoise mines near Nishapur, in Persia, from report of Consul-General Elias). Col Guard–Sept. 25. 700 w.

*8591. A Compound Winding Engine. W. Galloway (The substance of a paper read before the North of England Inst. of Min. & Mech. Engs. Describes an engine recently erected at Llanbradach colliery, near Cardiff). Col Guard–Sept. 25. 1800 w.

*8593. The Brancepeth Colliery Explosion (Interesting particulars of the accident). Col Guard–Sept. 25. 5000 w.

8595. The Report on the Twin Shaft Disaster (Extracts from report to Gov. Hastings, of Penna., by the mine inspectors appointed to investigate the disaster). Eng & Min Jour–Oct. 3. 1100 w.

*8598. Gold in Western Ontario (Editorial review of the diffusion of gold in this province, the amount of development work, value of deposits, &c.). Can Min Rev–Sept. 2500 w.

*8599. Silver Mining in Kootenay, B. C. (Editorial review of silver mining in British Columbia, with illustrations). Can Min Rev–Sept. 4800 w.

Miscellany.

*8193. Hanging Fire of Grisounite Cartridges. M. Sarrau (From a report to the French Firedamp Commission. Accidents resulting from slow or partial explosions, or from explosions after detonations were heard). Col Guard–Sept. 4. 1300 w.

*8206. The Mansfield, Indiana, Sandstone. T. C. Hopkins (Description, with account of tests and results. Its durability, etc). Stone–Sept. Serial. 1st part. 3000 w.

*8207. Thuringian Quarries. H. J. W. in *New York Post* (Describes a tour of inspection of the gray wacke and slate quarries under control of the ducal government). Stone–Sept. 1300 w.

*8253. A New Prospect. Arthur Lakes (A practical example of how it is examined and the hardships connected with it). Col Eng–Sept. 1500 w.

8341. Colorado, 1889-1896. T. A. Rickard (A retrospect of the years which have lapsed and a consideration of interesting features). Eng & Min Jour Sept. 19. 2600 w.

8342. The Colorado Meeting of the American Institute of Mining Engineers (The programme of the meeting, with brief abstracts of a number of papers presented). Eng & Min Jour–Sept. 19. 4000 w.

*8398. Machinery for the Coolgardie Gold Fields. Allison D. Smith (Stating the need of machinery and suggesting the list of goods most needed, with editorial urging England to supply the need). Machinery, Lond–Sept. 15. 2500 w.

*8400. Miners' Lamps and the New Method of Testing Them (Brief illustrated description of method recently used in Austria). Mach, Lond –Sept. 15. 700 w.

*8462. Round Ropes v. Flat Ropes. George W. Westgarth (From a paper read before the British Soc. of Mining Students. Gives an instance showing the superiority of round ropes). Eng, Lond–Sept. 18. 800 w.

*8464. On the Choice of an Oil Engine for Mining Purposes. C. C. Longridge (A few simple principles as a guide to the purchase). Min Jour–Sept. 19. 1000 w.

*8466. The Manufacture of American Coke in 1895 (Extract from report by Mr. Joseph D. Weeks. Production, extent of the industry, prices, etc). Col Guard–Sept. 18. 1700 w.

8469. Colorado Meeting of the American Institute of Mining Engineers (List of the 43 papers presented, with brief abstracts of some of them). Eng & Min Jour–Sept. 26. 5000 w.

8471. Railroad Absorption of Mineral Lands in California. A. H. Ricketts (Explains the situation by which the Southern Pacific Railroad Co. have gained possession of mineral lands in California). Eng & Min Jour–Sept. 26. 1000 w.

*8484. Transmission of Power by Compressed Air. John Garvas (Advocates compression by stages to lessen the difficulties and losses in the direct compression of air). Aust Min Stand –Aug. 27. 2000 w.

*8589. The Health Conditions of Coal Mining. James Barrowman (A paper read before the Min. Inst. of Scotland, and printed in the Transactions of the Federated Inst. of Min. Engs. Statistics proving that even after including deaths from accident, the mortality among coal miners is less than that of most manual occupations). Col Guard–Sept. 25. 2600 w.

*8600. The Economic Value of Coal Dust. W. Blakemore (A brief paper summarizing the uses to which coal dust may be applied and the extent to which it has already been used). Can Min Rev–Sept. 1500 w.

*8632. A Reign of Coal and Iron (Progress achieved in these industries during the reign of Queen Victoria). Ir & Coal Trds Rev–Sept. 25. Serial. 1st part. 3800 w.

*8613. Economic Aspects of the Coal Industry (The first part deals with the extent and duration of the English coal fields). Ir & Coal Trds Rev–Sept. 25. 1200 w.

We supply copies of these articles. See introductory.

MUNICIPAL ENGINEERING

The Gas Light and Coke Company, London.

THE PROGRESSIVE AGE (Sept. 1) contains an abstract from "Notes on London Gas Supply," by James McGilchrist, which shows the magnitude of the business conducted by the Gas Light and Coke Company of London. From this statement we gather that the capital of the company is $60,000,000, and the present value of its stock $150,000,000. The company supplies gas to the buildings occupying seventy square miles of territory. The business of the company is conducted in nine different district offices. There are a large number of testing-stations and twenty-three valve-houses, with nearly four thousand valves on district.

"Beckton and Bromley supply practically one-half of the gas required, and they are what are known as high-pressure works, gas being sent out at times from them under no less a pressure than 300-tenths. Many of the up-town stations have districts assigned to them which require more gas than the station's manufacturing capacity. They have, therefore, to rely upon the balance being sent to them by means of the high-pressure system of mains, which practically interlace the whole of the company's twenty-seven districts. In addition to this, each up-town station has to take in a supply of gas into separate holders allocated for the purpose, to supply their proportion of the districts assigned to Beckton. Further, each up-town station has to take in a supply of gas from the high-pressure system sufficient to enable them (by means of their reversing pumps) to pump gas back into the high-pressure mains during the hours of heavy draught, to cushion up the pressure which is needed to supply the various district valve-houses with the necessary initial pressure. The pumping mains act in the double capacity of gas-holder supply-mains and district valve-house supply-mains. All the works, stations, etc., are connected by telegraph with Goswell road, and everything there is so arranged that the chief has only, as it were, to pull the string, and the figure moves.

"Gas manufactured at Beckton has to travel in a direct line seventeen miles, and experiment has proved that, if no other station were pumping into these mains during the time the heavy draught is on, 300-tenths pressure at Beckton would be reduced by consumption and friction to about 10-tenths at the extreme end, Fulham. There are also a number of districts which are known as transfer districts, and which, by means of valves *in situ*, can be supplied from different stations as may be desired, having regard to the stocks of gas available at the particular station. There are also a number of pressure stations all over the districts, situated at spots where pressures are known to be lowest, and the pressure-register sheets are forwarded each day to the central office as a guide for the future working of such pressure."

There are many widely different levels, and many districts are separately valved off to insure to each station its quota of distribution.

Particular attention has to be paid to the city (proper) of London. The city abounds in vaults and cellars (some of them seventy-five feet below the pavement level), in addition to the numerous underground railway stations and signals, all of which are lighted with gas, and Mr. Gilchrist says that "chess-playing is simply not in it with this—the London gas supply—as regards concentration of mind."

The company has two thousand miles of main pipes laid, ranging from forty-eight inches in diameter downwards. It supplies fifty-five thousand public lamps. Such of these as are not supplied to vestries and parishes under the average meter system are lighted and extinguished at the average rate of 1,500 per minute.

The company employs an army of over ten thousand men. It supplies a quarter of a million consumers. It has hired and sold 114,000 gas-stoves. Its gas-holders have a capacity for 115,000,000 cubic feet of gas, or about ninety per cent. of a heavy day's output. The heaviest day's output yet made is stated to be 128,000,000 cubic feet, for which, in round numbers, twelve thousand tons of coal had to be carbonized. Notwithstanding the magnitude and difficult conditions of the service, the loss by leakage is only a fraction more than five per cent. Some large places of amusement require 12-inch service pipes.

The Leicester Sewage Farm.

A LONDON correspondent has sent us a summary of a statement made by Mr. E. G. Mawbey, the borough surveyor of Leicester, England, which was put forth in a discussion of a paper on the present status of sewage irrigation in Europe and America, presented at the recent Sanitary Institute Congress, at Newcastle-on-Tyne.

The conditions at Leicester were considered very unfavorable to a sewage-irrigation system, yet very creditable success has been attained in the face of all the difficulties, arising chiefly from unsuitability of the soil. Mr. Mawbey, having carried out all the preparation of the land, particularly a new system of sub-drainage, explained the arrangements whereby, on clay land, the successful purification of the dense sewage of Leicester (population, 200,000) had been successfully accomplished.

The system was put in operation six years ago, and the land has been sewaged for six years. This is certainly long enough to demonstrate the success or failure of the system, and its success seems now entirely assured.

One of the most important factors of the success is that, whereas the foul affluent which always gets into the drains of clay land generally runs into the water-courses and rivers, the foul effluents in this scheme are run out on to the surface of lower land again and again, and a high condition of purification is effected and maintained, notwithstanding that the summer flow of water in the river is often less than the volume of sewage treated.

With reference to the above statement, Mr. Rogers Field said, in substance, that he regarded the successful experiment at Leicester as demonstrating the fallacy of an opinion hitherto entertained that successful sewage irrigation can be carried out only where land of a suitable description is obtainable. It often happens that land hitherto considered suitable can be had only at an exorbitant price, while unsuitable land can be had in large quantity and at a low figure. The demonstration of the possibility of effective sewage purification on unsuitable land is, therefore, of national concern. What has been done at Leicester is greatly in advance of anything in this direction hitherto accomplished, and the problem is solved by the re-application of the effluent from the land drains.

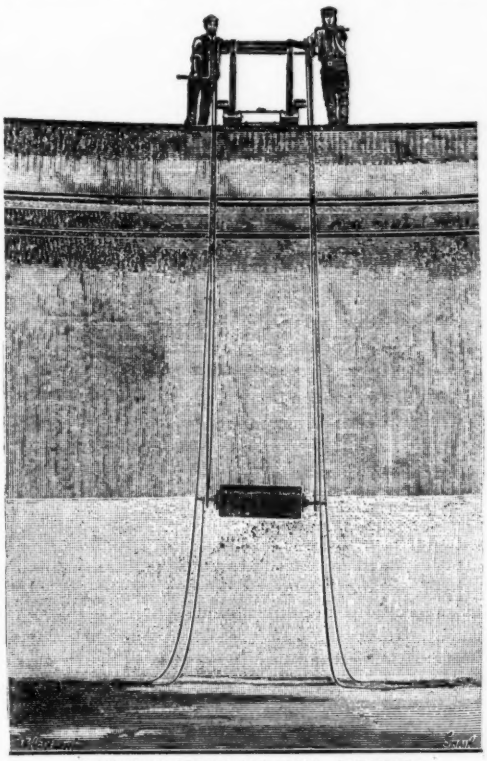
The *Leicester Daily Post*, commenting upon Mr. Mawbey's statement, and upon the system which he has evolved, says:

"Even when the soil is in every respect adapted for the purpose, the process of sewage purification and utilization is by no means as easy as many imagine. When, however, as at Beaumont Leys, the engineer is confronted by a stiff clay, a vast volume of sewage, and the most sluggish water-flow in all England, he may well despair. Happily, Mr. Mawbey has not only proved fully equal to the emergency, but has solved the problem in a fashion which the gratifying experience of the past six years has demonstrated to be a complete success. We can still remember the confident predictions of hopeless and extravagantly expensive failure amid which the experiment was launched, and which have long since been so pleasantly falsified. Nor have we far to seek for the open secret of success. It is to be found in the tact with which Mr. Mawbey has contrived to make abundance in quantity neutralize and compensate for lack of quality. That the measures which have been taken have proved a gratifying success is shown by many facts. One is the character of the effluent, which has disarmed the hostility of even the rivers pollution com-

mittee of the county council. Another, and by no means least significant, is the abandonment of all purification by chemicals."

Device for Cleaning Sides of Open Reservoirs.

THE sides of open reservoirs often get foul with vegetable growth, amongst which much minute animal growth finds a habitat. When such accumulations are to be removed, as may happen according to the rapidity with which the walls become loaded, wire brushes, scaffolding, and other paraphernalia are, in the ordinary way, required for the operation, and a deal of hard labor is expended. The device herewith illustrated is designed to facilitate and lessen the labor now required for cleaning reservoir walls. According to *The Engineer* (Sept. 11), from which the engravings are reproduced, the machine was designed by Mr. J. F. Rodda, superintendent of the Eastbourne (Eng.) waterworks.



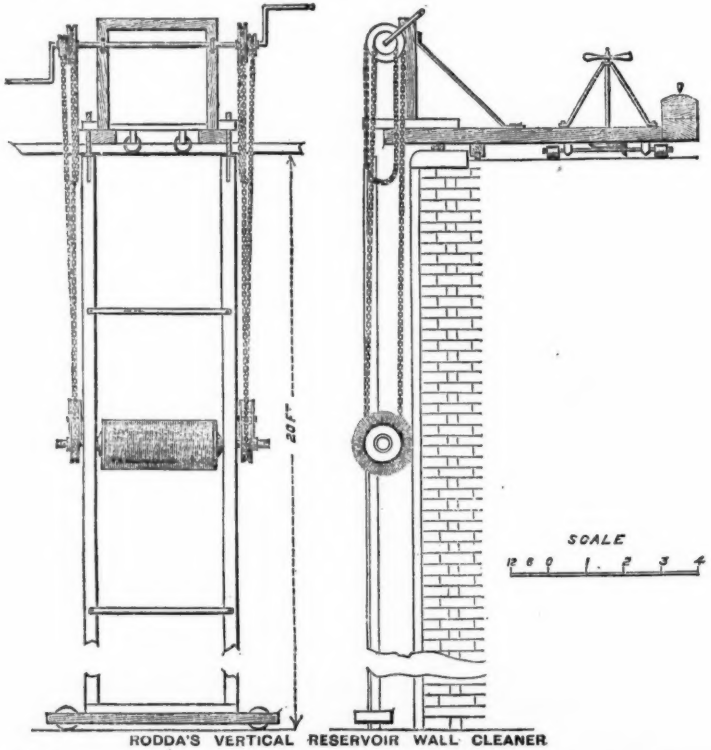
RODDA'S RESERVOIR WALL CLEANER

The engravings are so self-explanatory that a very brief description suffices. "The wood frame is fixed on low wheels to facilitate its being worked around the coping of the reservoir wall easily by means of a pair of bevel wheels. The revolving broom is hung in differential pulley block chains carried over the usual sprocket wheels, and running up and down in light angle iron guides hung on the wood frame, when used in cleaning vertical sides of reservoirs. If the sides of the reservoir are sloping, the guides are not necessary, as shown by the above view from a photograph herewith. A flexible hose is attached to the wood frame, joined to a sprinkler which conveys a stream of water down the side of the wall being scrubbed."

The Metering of Water.

WHILE admitting that there is an enormous waste of water in cities which would be checked by metering, the universal application of meters was objected to by Mr. R. E. W. Berrington, in a paper read by him before the British Association of Water-Works Engineers. An abstract of the paper (*Journal of Gas Lighting*, Sept. 1) sets forth his reasons for this objection. The waste of water in the United Kingdom, declares the author, is so enormous that, were a monetary value placed upon it, it would be viewed as a national calamity; yet he thinks meters used as a check to this waste would so stint the use of water among those who need it most that the effect would be insanitary. To save a little money those who get money by the hardest toil and those in

penury would use as little water as possible, and thus their already insanitary condition would be intensified. Much of the waste of water in cities is not due to wantonness, and may be checked without resort to meters. Yet, as this is largely underground waste, it adds its insanitary effect to existing evils. Sodden ground underneath, and in the near vicinity of crowded tenements, is a source of great danger to the occupants. Subsidence of service pipes, defective joints, defective ball-taps, unduly large flushes for water-closets, taps subject to frost in open courts, etc., are named as important sources of waste.



RODDA'S VERTICAL RESERVOIR WALL CLEANER

The waste meter system and house-to-house inspection have been found effective in restricting waste. An instance of a reduction of consumption of three gallons per head resulting from a single inspection is cited. "In new works it is easy to arrange for the waste-meter system; and it is desirable to make such provision. The insertion of a stop-tap on each service should be looked upon as a *sine quâ non*. The water engineer manages his works as well for a company as for a corporation; but the author supposes there will be a consensus of opinion that the supply of such an essential as pure water should be in the hands of the local authority. It is a question as to whether the water and sanitary arrangements of the household should be under the immediate control and actually maintained by the local authority,—first, on the score of public health, and, next, in order to secure efficiency and economy in those works in which the general community has a direct interest. The competition among plumbers, and the desire of householders to get the work done cheaply, lead to the use of

much inferior material and bad workmanship; and this often means disease and deteriorated health, if not death."

It is suggested that in every water-works a system of stamping fittings should be in operation, and samples of approved fittings should be exhibited; that mains should be laid with not less than 2 ft. 6 in. or 3 ft. cover, and that they should be tested before being covered up; that reliable self-closing taps may be introduced with advantage in many cases, and without the concussion that used to be experienced with the old type of tap; that economy in water will often effect a saving in capital expenditure, annual working expenses, and wear and tear of machinery. The following table shows the quantity of water which escapes through small apertures, the figures being from actual tests:

Description of Fitting under Test.	Gallons Wasted in 24 Hours.
½-inch bib-tap, washer bad.....	700
⅜-inch tap, washer bad.....	920
¾-inch tap, screw stripped.....	12,720
⅜-inch ball-tap, washer bad.....	900
⅜-inch ball-tap, lever strained.....	200
Pipes burst by frost, ⅜ inch.....	11,280
" " " ½ inch.....	17,280
Taps left open, ¾ inch.....	23,520
" " ½ inch...	12,000
" " ⅜ inch.....	9,600

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply.

8160. Inclined Retorts at Cassel, Germany. Emil Merz (Abstract from a paper read at the German Assn. of Gas and Water Engs. A general description of the system and statement of its results, which have proved good). Am Gas Lgt Jour–Sept. 14. 1400 w.

*8176. Gas Lighting by Incandescence (A general illustrated review of progress in the art of incandescent gas-lighting, compiled from the most authoritative sources). Engng–Sept. 4. Serial. 1st part. 1400 w.

*8246. The Decomposition of Hexane by Heat. F. Haber and H. Samoylowicz (Main features of some recent German experiments). Gas Wld–Sept. 5. 1200 w.

8372. The Coming Light. From *L'Illustration* (Illustrated description of the Denayrouse lamp). Sci Am Sup–Sept. 26. 1600 w.

*8449. The Self-Enrichment of Coal Gas. R. G. Shadbolt (Read at Eastern Counties' Gas Managers Assn., Retford. An exceedingly interesting account of a series of persistent experiments resulting in the development of a new method for which a patent has been secured. The method is simple and requires no labor expenditure after the apparatus (illustrated) has been installed. An average enrichment of two candles is claimed as the result. Discussion postponed till ensuing meeting). Gas Wld–Sept. 19. 4500 w.

*8450. Observations on the Construction and Working of Regenerator Settings. W. J. Jenkins (Read at the Eastern Counties Gas Managers Assn., Retford. The aim of the paper is to point out divergencies from a reasonable theory as found in many types of construction and to evoke discussion on the opinions advanced). Gas Wld–Sept. 19. 4200 w.

†8487. Acetylene the New Illuminant. V. J. Youmans (General review of progress in the manufacture and use of acetylene as an illuminant). Pop Sci M–Oct. 3000 w.

Sewerage.

8136. The Sewerage and Sewage Disposal Systems of Plainfield, N. J. Andrew J. Gavett (Illustrated detailed description. Irrigation system. Contract prices for different parts of the work). Eng News–Sept. 10. 7000 w.

*8243. Chemical Sanitation and Public Health. William Brown (Illustrated description of low-level drainage system at Sutton in Surrey, Eng., and remarks upon antiseptic sanitation in connection with this kind of drainage). San Rec–Sept. 4. 2000 w.

*8317. Jointing of Sewers and Drain Pipes. R. S. Rounthwaite (General defectiveness of this class of work. Methods employed are described and criticised). Ind & Ir–Sept. 11. 2200 w.

*8318. Sewerage and Sewage Disposal of Colliery Villages. John Edward Parker (Read at the congress of the Sanitary Inst. Newcastle-on-Tyne. Insanitary condition of many colliery villages. What has already been done, and what remains yet to be done for their improvement). Ind & Ir–Sept. 11. Serial. 1st part. 800 w.

*8568. Manchester Sewage Disposal (Description of important extensions of the sewerage system of Manchester, by a scheme of effluent disposal, and a further scheme of sludge disposal, in addition to the original scheme of main drainage now being carried out). Eng, Lond–Sept. 25. 4500 w.

Streets and Pavements.

*8126. Pavement Construction and City Growth. Stevenson Towle (Discussing the various types of pavement in their relations to health, wealth and comfort). Eng Mag–Oct. 4900 w.

†8233. Street Cleaning (From the *Brooklyn*

Eagle, commenting upon the section on street cleaning in the proposed charter for Greater New York). San-Sept. 2800 w.

*8544. Granite Paving in Berlin. Robert Grimshaw (Illustrated description, as per instructions of the city inspector). Munic Engng-Oct. 2000 w.

*8546. Cost of Single-Course Brick Street Pavement. T. S. McClanahan (Abstract from paper read before the Ill. Soc. of Engs. The method of laying 4,878 square yards of brick paving, inclusive of preparation, and the detailed cost of the entire work is given. The pavement is shown to have cost $1.43 per square yard). Munic Engng-Oct. 400 w.

*8548. Experiments on Vitrified Paving Brick. F. F. Harrington (The testing laboratory of the St. Louis water, sewer and street commissioners is the place where the experiments described were conducted. Results of uniform tests of a variety of paving bricks are presented, with three plates of diagrams). Jour Assn of Engng Soc-Aug. 3000 w.

8609. Brick Pavements (Read before the Massachusetts Highway Assn., by James A. Davis. A general review of the progress and present status of brick paving, from which the author concludes that pavements of good brick, properly laid in the manner he describes, are superior in all respects to any other known kind of pavements). Brick-Oct. 2000 w.

Water Supply.

*8129. The Water-Supply of a Tropical City. Ill. Raimundo Cabrera (Describing the construction of the famous Canal de Vento at Havana). Eng Mag-Oct. 3800 w.

8174. The Southbridge, Mass., Dam (Brief illustrated description of dam for the new water supply). Eng Rec-Sept. 12. 500 w.

8175. Omaha, Neb., City Water Works. Owen T. Smith (Development, general design and construction, pumps, pipe line, settling, aeration, general plan and section of basins and arrangement of pipes at pump-house). Eng Rec-Sept. 12. Serial. 1st part. 1600 w.

†8232. Purification of Water by Metallic Iron. C. W. Chancellor (Description of the process as carried out at Antwerp and other European cities). San-Sept. 2400 w.

8282. Scranton, Pa., Water Supply (Illustrated description). Fire & Water-Sept. 19. 800 w.

*8292. Mechanical Filtration (Editorial discussion of mechanical filtration as carried out in the United States). Engng-Sept. 11. 1500 w.

*8313. Revolving Broom for Cleaning Sides of Open Reservoirs (Illustrated description). Eng, Lond-Sept. 11. 200 w.

8523. Filtration of the Philadelphia Water Supply (Review of the movement in Philadelphia for better water and of the report of Mr. Allen Hazen upon a system of filtration of the supply). Eng News-Oct. 1. 1100 w.

*8545. The Financial Management of Water-Works. Freeman C. Coffin (Abstract from paper read before the New England Water-Works Assn. Pertains wholly to municipal water-works, and deals with several important questions relating thereto). Munic Engng-Oct. 3400 w.

8550. Thirty Million Gallon Hammond Water-Works Engine at Buffalo, New York (Illustrated description). Power-Oct. 700 w.

8561. A Special Street Fire Hydrant (Illustrated description of a special form of hydrant developed in Providence, R. I., where the water pressure in the business districts is delivered at a pressure of 105 lbs. per square inch). Eng Rec-Oct. 3. 700 w.

8581. Newark's Water Supply (Illustrated description of waterworks at Newark, N. J. Fire & Water-Oct. 3. 1200 w.

Miscellany.

*8161. The Importance of Sanitary Inspection. Andrew Young (Extracts from report of the chief inspector of the Chicago Health Dept. The welfare of the common man, not alone those who can afford to live in luxury, should be the aim of all health boards). Pl & Dec-Sept. 1200 w.

†8201. The Henry-Campion Destructive Incinerator (Illustrated description of a destructor furnace invented by G. Henry and J. M. Campion, Executive Engineers of Umballa, India). Ind Engng-Aug. 8. 1300 w.

†8230. Public Baths Essential to Public Health. Moreau Morris (Read at a public meeting held in the Aldermanic Chamber, City Hall, New York. A strong plea for establishment and maintenance of public baths). San-Sept. 1500 w.

†8234. Suburban Sanitation. G. B. Thornton (Read at meeting of Tennessee Medical Soc., at Chattanooga. Need for better suburban sanitation and plans discussed. Reprinted from *Commercial Appeal, Memphis*). San-Sept. 2500 w.

8327. The Buffalo Free Bath-House (Illustrated detailed description). Eng Rec-Sept. 19. 3000 w.

*8376. The Government of Greater New York. Francis V. Greene (Presents the difficulties and needs, the existing conditions, etc., with reference to city government in various parts of this country and in foreign lands. Contains interesting information). Scribner's Mag-Oct. 7000 w.

8533. Electricity in Cleaning City Streets (Illustrated description of the latest development in the art of street cleaning. A self-loading car removes the surface accumulations and is driven by electricity taken from the trolley wires). W Elec-Oct. 3. 600 w.

8582. The Fire Departments of Europe in Comparison with American. Chief Hosmer (Read at convention of the Mass. Fire Assn., at Brocton, Mass. A very interesting comparison based upon personal observation and study). Fire & Water-Oct. 3. 4600 w.

8627. Garbage Utilization at Cincinnati and New Orleans (Illustrated description of apparatus, and the Simonin process of treating garbage, as carried out in the cities named). Eng News-Oct. 8. 5000 w.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

Some Interesting Points in Rapid Transit.

In the *Railroad Gazette* (Sept. 11) there appeared a striking and admirable analysis of typical urban passenger-travel, prepared by Mr. Theo. Cooper and based upon the station-to-station traffic of the New York Manhattan (elevated) system. The most notable conclusion drawn by Mr. Cooper from the table was "that express travel on a rapid transit road will not pay."

In the Sept. 25 issue of the same excellent journal Mr. Wm. Barclay Parsons, the engineer of the New York rapid transit commission, ably reviews Mr. Cooper's arguments, but supports very different conclusions. It is noteworthy at the outset that the broadening effect of a thorough engineering training is manifested in the toleration extended by both debaters to the views of opponents, and the readiness to grant that incomplete data, especially, may be combined to accord with more than one hypothesis.

The data in this case are admittedly insufficient, and, pending their completion, Mr. Parsons says:

"In the study of the rapid-transit problem, an interesting feature has been the great divergence of opinion on this subject, the opinions varying all the way from the extreme on one hand, as represented by Mr. Cooper, to the extreme on the other of maintaining that only the fast traffic will pay, and that, if a road were built for express service alone, the greatest returns would be obtained on the investment. Of course, until the experiment is tried, all statements in this regard are largely matters of personal opinion, and the writer is of the belief that the best results will lie somewhere between the two extremes, and be reached by a proper combination of local and express service."

The first point of general importance which he brings out is that an apparently trivial saving in time is apparently regarded by the average passenger as highly valuable. This is in line with Col. Prout's conclusions in his article in this number of THE ENGINEERING MAGAZINE. Suburban travel is there shown to be the class most largely increased by an increase of train-speeds; the same principle would naturally apply with still greater force to the shorter distances of urban traffic.

Mr. Parsons's conclusions are derived from a study of the conditions as they manifest themselves in New York; but they are so indicative that a citation of one of his instances, at least, will be of wide value and interest.

"The Third avenue road during the busy hours in the afternoon runs each alternate train from City Hall as an express train. Inasmuch as these express trains are sandwiched between locals, the only benefit that can be derived from them is where they reach section trains of third track,—namely, north of Fifty-ninth street, —and the greatest number of local trains that they can pass there is three, while frequently they do not pass more than two; yet passengers will leave the preceding local trains at Fifty-ninth street in order to take the express trains, although they know that these express trains are so crowded that a seat is an impossibility, and that the gain will not be more than one or two trains. On the west side the express trains do not stop after leaving Franklin street until reaching One Hundred and Sixteenth street, and yet passengers in large numbers on every express train will go to One Hundred and Sixteenth street, which has an island platform, and then wait for a southbound local and go back, some as far as Eighty-first street, a distance of 1¼ miles or a total extra journey of 3½ miles, as by thus going beyond their destination they can save about three minutes.

"It is the knowledge of these things that leads those who differ with Mr. Cooper in the other extreme to claim that

the express-train service will be the most used, and, therefore, the most profitable. If people will resort to these expedients for the small saving in time that has been mentioned, is it unreasonable to suppose that, where every facility is offered for a transfer,—namely, merely stepping across an island platform,—passengers will avail themselves of it?"

The second, and perhaps still more widely important, point which Mr. Parsons brings out, collaterally to his main argument, is the extraordinary effect of reduction of fares in increasing volume of traffic and net revenue to the transportation companies. The Manhattan system is again the typical example:

"In the fiscal year 1887 the Manhattan system introduced a five-cent fare through the whole twenty-four hours, previous to which time it had been charging five cents during certain hours of the day and night and ten cents during the remainder of the day. Previous to that its annual increase in travel had been from six to ten million passengers, and yet its increase during 1887 amounted to 44,600,000 fares as against a total business for the preceding year of 115,200,000, or a sudden increase of over 38 per cent. Of course, the natural conclusion would be that such suddenly abnormal increase without the addition of any new lines would mean that the business was taken entirely, or almost entirely, from the surface-roads. As a matter of fact, the surface-roads showed a loss of only 8,000,000 passengers, and the total traffic gain for the city was 36,500,000, as against a normal increase of from 15,000,000 to 16,000,000 during the previous years. That is to say, the giving to the public of a fast service at no greater cost except the personal inconvenience of climbing the stairs more than doubled the normal annual increase. It is interesting to note that this reduction in fare caused an increase not only in gross receipts of the Manhattan Company, but actually in the net receipts after paying operating expenses, and that the reduction of the fare was a source of increased revenue to the company."

This experience is earnestly commended to the attention of some of our contemporaries who can see nothing in proposed fare-reductions except a directly proportionate reduction of total revenue to the road, to be met (according to their conceptions) only by a corresponding cut in employees' wages.

Theorizing from imperfect data is very uncertain. The test of experiment does not seem to have established "the fallacy of cheap car-fares."

The Widening Approval of the Tie-Plate.

THE general attitude of maintenance-of-way men toward the tie-plate, as defined by the reports of the committee on roadway of the American Society of Railroad Superintendents and the committee on tie-plates of the Roadmasters' Association of America, shows a very strong agreement as to essentials, and a rather remarkable disagreement as to details.

There seems to be complete accord as to the "qualities necessary in a tie-plate to fulfil the service it is called upon to perform," which, following the abstracted reports in *Engineering News*, are defined by the superintendents' committee:

"1. Adhesion to the tie, so that it can be considered as practically a part of it, preventing damage to the wood-fiber, and rattling by passing trains.

"2. Adhesion to the tie to prevent its lateral movement, even on curves of high degree, so that the track cannot spread.

"3. The above vertical and horizontal adhesion to be obtained by such a mode that it will not assist decay of the tie.

"4. It should be so constructed that its application be simple and economical.

"5. Its cost should be sufficiently low so that, when added to the total cost of the tie in place, it will, by sufficiently prolonging the life of the tie, pay for itself, due allowance being made for a saving in labor on track-repairs, and a better condition of track.

"The fulfilment of these requirements should have the following results:

"1. Prevent damage to the tie by the rail cutting into it;

"2. Make the use of rail-braces unnecessary;

"3. Make possible the use of soft wood and longer-lived ties on curves as well as on tangents, and on all conditions of track;

"4. Make possible the use of a tie in the track during its natural life under the most trying conditions of alignment, grade, and traffic;

"5. Greatly reduce the expense of maintenance of track to proper line and surface;

"6. Make possible the maintenance of track in a safer condition, and afford relief to our forests of tie-producing timber."

That these results are in large measure secured in all cases is at once apparent on reading the correspondence submitted with the report. Forty-nine roads out of seventy-three responding to the superintendents' committee's inquiries had had more or less experience; the reported increase in the life of the tie varies from thirty per cent. to one hundred and fifty per cent., the difference being most noticeable on curves and under trying conditions of alignment and traffic. As to the other points, the selection is concisely summed up by the roadmasters' committee thus:

"On the second division of the subject-matter: 'Will the Use of Tie-Plates Dispense with the Use of Rail-Braces?' your committee, after a most thorough and searching experiment and investigation, unhesitatingly state they will do so. We have received reports showing where they have proved successful on curves of 3° 30′, 4° 25′, 15°, and even on 60°, where they have held the rail in place without any rail-braces being used. Moreover, no lateral movement or cutting of ties has occurred on these curves, and the track is in perfect and true gage. Your committee has had reports from chief engineers and roadmasters in all sections of this country, where ties have been used under almost all possible conditions with and without tie-plates, and the reports received show that the use of the tie-plate is a very necessary appliance on all track-work.

"Its use is economic, as it reduces the repairs on the road-bed, and makes a more perfect track, with consequent reduction on repairs of rolling stock. Further, its use as a measure of safety is beyond question, for it means truer gage to the track. Your committee unite in recommending the general use on all repair and construction work of the tie-plate, and feel that its added cost to the track maintenance will be more than compensated by the cost of labor saved in tie renewals alone."

But, passing from results to types, harmony gives way to confusion. Wide plates and narrow plates, thick plates and thin plates, flat plates and shouldered plates,—all have their advocates.

"It is observed that, where a very positive preference is expressed for a particular kind of plate, it is often the case that no experience has been had with any other form, which is a good argument for tie-plates in general, but not a strong one for the superiority of one form of plate over the other. There are some notable exceptions, however, where, after having made extensive experiments with several kinds of plates, one particular form has been finally adopted. These cases are deserving of the most serious consideration."

The greatest diversity of opinion is upon the question "whether the union of the plate with the tie shall be secured by ribs entering the tie parallel with the grain, or by lugs or claws entering the tie at right angles to the grain. Of the forty-four opinions received on this point, twenty-eight declare their unqualified preference for the plate with longitudinal ribs, eight are equally as positive in their preference for the other form, three appear to be as well satisfied with one as the other, and five have not yet formed a positive opinion either way."

The majority is large in favor of the longitudinal rib; it is amusing to notice that, while some oppose the form, as tending to split the ties, others advocate it, because, "when the tie begins to decay, the longitudinal flanges hold the soft fibers of the wood together, thus prolonging the usefulness of the tie."

Probably each form has its special merits for certain situations or certain kinds of wood, and only much wider experience can settle upon standards adjusted to varying conditions of practice.

The Profession of Railroading.

COL. H. G. PROUT, in addressing the Western Railway Club in response to the toast, "The Press," at Chicago, Sept. 15, summed up so admirably the proper relation of railroad men to their work that we can do no better than give that portion of his address *verbatim*. Col. Prout said:

"I have spoken of the railroad profession. Perhaps this is premature. Perhaps I should have said railroad business, or occupation, or calling. Perhaps railroading is not yet a profession. The Century dictionary defines a profession as 'a vocation in which knowledge is used by its practical application to the affairs of others in serving their interests or welfare.' Worcester has defined it as 'an employment requiring a learned education.' Obviously, railroading does not yet fill this definition. No one has yet organized a course of study by which one shall become possessed of the fundamentals of railroading as a learned education. There is an effort now on foot to establish such a course in one of the great universities, but the president and some of the faculty of that university, and many old railroad officers, have doubts if this calling can be organized into a profession to be prepared for by systematic courses of study in college. It seems to them too big and complex. It seems to be too much affected by the ever-changing conditions of human life to permit it to be taught as a science with fixed laws. The art of its administration, like the art of government, cannot be imparted by teachers to pupils as can the principles of the law and the gathered wisdom of the pathologist.

"Many other professions contribute to the administration of the railroad, but the engineer, the architect, the lawyer, the doctor, even when they give their lives to the service of the railroad, still remain professional engineers, architects, lawyers, and doctors. But this is not the whole story.

"A profession is more than a calling for which one is prepared by learned education. When we say profession, there at once arises in our minds the thought of an unwritten, unformulated body of tradition which governs conduct. There at once comes up a notion of a special standard by which we measure performance. We remember that we ask first and always of a professional man that he should do the work which he undertakes for someone else just as well as he possibly can, regardless of its effect on his own fortunes. We remember that a professional man may be highly successful, and yet make no money for himself. When we think of a man who has attained real eminence in his profession, the last thing that we think of is his private fortune or his public office. A profession, then, is a calling around which have grown up certain traditions of self-sacrifice, for which mankind has set up certain very exacting standards which demand in its followers, above all other things, devotion to duty. Thus we get at a simple expression of the bottom principle of the profession which distinguishes it from other callings or occupations. The professional man assumes an obligation towards his client; until he gives up that obligation, his duty to his client takes rank before his duty to himself. All this we may sum up in the term 'professional spirit.'

"Now, I come to the bearing on you and me of this attempt to state what we mean by a profession. I like to think that the professional spirit is growing fast among railroad officers. Whether or not railroading is a profession; whether or not it ever can be a profession,—is a small matter; and the vital thing is that railroad officers should have the professional spirit. We must look to this spirit to save the railroads from the ignorant and corrupt subordinate. We must look to it to save the railroads from the brigands in high places seeking only to make their own fortunes. Perhaps we must look to it to save the railroads from confiscation by Socialists and Populists, and, in fact, by honest voters who would come to be classed with either. How the professional spirit will do all this I need not point out. It will administer the properties for the interest of their owners, and not for the profit of salaried officers. But, in the long run, the interest of the owners is the interest of the public, and thus we find the probable solution of

much that is most troublesome in what is called the railroad problem."

Col. Prout makes a particularly impressive point when he refers to railroading as being "too much affected by the ever-changing conditions of human life to permit it to be taught as a science with fixed laws." In no other branch of modern development, perhaps, have the standards of yesterday been so little applicable to the work of to-morrow.

The situation is like that of Alice in Wonderland, when she ran furiously until exhausted and breathless, only to find that she had merely kept abreast of the country, which, when she stopped, rushed swiftly past her. The marvelous expansion of the past quarter-century has kept the railroad only abreast of the times; the wonder is, not that so few roads have passed the ordeal with financial success, but that so many have met the ceaseless demand for more money, broader measures, and abler men.

There seems to be a pause now, but the impression may arise merely from the human tendency to cling to the fixity of the present. He would be an unwise prophet who should predict more than that, whatever the development, the railroads will be equal to the demands.

State and Corporate Railway Ownership.

THE advocates of State ownership of franchises generally, and of railways in particular, might find interest, if no great satisfaction, in studying the results of experience in India. The construction and operation of railways there, according to *The Indian and Eastern Engineer*, has been governed by a policy which "has constantly changed, and will, no doubt, change in the future with circumstances which are constantly altering"; but it has always involved a larger or smaller measure (and generally a larger one) of State management.

A writer in *The Economist* says: "It was the intention of the statesmen who were responsible for the first beginning of railways (in India) that, as far as possible, these should be free from the evils which have marked the growth of railways in other countries." They determined that at least the main arteries should not be laid down haphazard, but that each project should be rigorously scrutinized in the light of its purpose as a part of a preconceived and symmetrical network, intended to serve the great centers of trade and, at the same time, strengthen the military and political position of the State.

"The agency then selected for the construction and working of these lines was that of guaranteed companies, who, in return for support, were subjected to rigorous control of their operations in every detail. This policy lasted for twenty years.

"But in 1869 a new departure took place. It was then decided to abandon the system of guarantee, as, indeed, of private enterprise in any shape, and to construct and work new lines by the direct agency of the State," "and so, it was supposed, save," comments the *Indian and Eastern Engineer*, "the enormous profits made by contractors under companies."

"For reasons which need not be here detailed, the policy of guarantee was again renewed in 1880 'in a modified form.'" "From this time we can follow the development of an instability of policy continuing to the present time," with results illustrated by the fact that there are now:

"(1) State lines made and worked by the State;
"(2) State lines made and worked by companies;
"(3) Lines made and worked by guaranteed companies;
"(4) Lines made and worked by assisted companies;
"(5) Lines made and worked by native States;
"(6) Lines made and worked (?) by native States and worked by companies."

"No parallel to this medley of conditions may be found in other countries, yet it may be safely asserted that in India, if anywhere, the government had a perfectly free hand to determine which method should be adopted."

The vacillation and confusion are traced largely to inharmony and conflict of authority between the government of India and the home government; but the essence of the matter, so far as the results and tendencies of State ownership are concerned, is summed up in the following paragraphs;

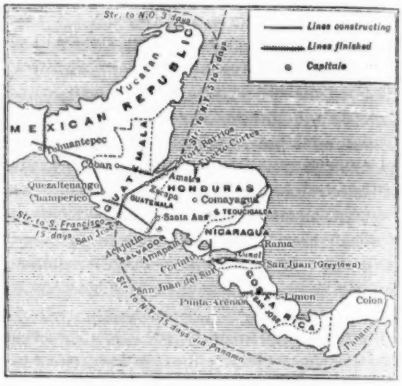
"The latest phase is to be seen in the tendency to relinquish the working of State lines by State agency, and to make them over to be worked by existing or new companies. Another equally important departure is in the re-arrangement and combination of the administrations of existing lines. The first of these is undoubtedly a move in the right direction, whatever may be the grounds for continuing the construction of railways by the State directly. There is now an almost complete agreement amongst the railway men in India that the working of railways by the State is less successful than by the agency of companies, notwithstanding that the former system has been tested by twenty years' experience, and although every endeavor has been made of late years to free the hands of the government officers. But the fault does not lie with them. It is to be found in the essential conditions of government administration, its inherent disposition towards centralization, its want of elasticity and of sympathy with the trader, its absence of initiative and of effective stimulus to its servants. The result is that the best men are drawn away by companies, by the attractions of better emoluments and better prospects, and it may be added that in no case have they failed to justify their selection.

"The position developed from the experience of the last few years seems to show that railway extension in India will not attain to the progress which the country now requires and desires, until the direct administration of railways by the State has ceased."

Railroad Development in Central America.

IN connection with the map reproduced below, *The Iron Age* says:

"Four out of the five Central American States are actively pushing the construction of railroads through their territory, several new concessions or grants having been made lately. The British company who were to build the western section of the Costa Rica Interoceanic having failed to comply with the conditions of their contract, the government has declared same rescinded, and a new contract has just been signed with New York, California, and Colorado capitalists to finish



THE RAILROADS OF CENTRAL AMERICA.

the western terminus, thus connecting the two oceans and passing through San José, the capital. This company have a capital of $1,500,000, and work will commence at once."

Several other projects are mentioned, some transisthmian and some designed to link the several republics together and eventually form a portion of the great North and South American Railroad of the future; but the greater portion of the space is given to "Northern Interoceanic of Guatemala," progress upon which is thus described.

"Rails have been laid (from Puerto Barrios) to Zacapa, on the central plateau, the most difficult work having been completed when the line crossed the swampy district of Amates and Tenedores. Grading has been carried to within sixty miles of the capital, and, as the work is mostly in the hands of competent contractors, it is expected that through connection from the capital to the Atlantic will be had by the end of next year."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

Construction.

*8181. Current Railway Construction (Notes of work now under way in England). Engng–Sept. 4. 900 w.

8439. New Shops at Concord, N. H.,—B. & M. R. R. (Description of structures and arrangement, with sketch plan). Ry Rev–Sept. 26. 800 w.

8451. The Park Avenue Viaduct Improvement, New York City (Descriptive account of an extensive and important piece of construction, with drawings of many details). Eng Rec–Sept. 26. 900 w.

8493. Activity in Railroad Building in Central America (A brief statement of work completed and in progress, and of the improvement in communication which will result. Map). Ir Age–Oct. 1. 700 w.

Electric and Street Railways.

8144. Compressed Air Traction (A letter from Robert Hardie, objecting to an editorial published in this paper, with remarks from the editor). Elec Wld–Sept. 12. 1300 w.

*8153. The Glasgow District Subway (Description of construction and operation of an underground rapid transit cable road just to be opened). Arch, Lond–Sept. 4. 1400 w.

*8156. A Combined Conduit and Overhead Trolley Tramway in Washington (Illustrated description). Ry Wld–Sept. 900 w.

*8158. The Working Expenses of Electric and Cable Railways (Tabulation of figures from various English roads, with analytical comment). Ry Wld–Sept. 1900 w.

8260. The Hirschberg-Warm-Springs-Hermsdorf Gas-Road (Description of construction, equipment and projected operation of a road using gas-engine motors. The cost is said to be very low. Illustrated with maps of the line, and rail sections). Pro Age–Sept. 15. 2000 w.

8266. Power from the Trolley Circuit—Is it Practicable? Why Do the Fire Insurance Companies Object? What Should be Done to Overcome the Objections? H. S. Newton (Argues in favor of the policy as economical and remunerative, and considers insurance opposition unwarranted and remediable). Elec Wld–Sept. 19. 1600 w.

8267. The Daily Inspection and Care of Car Equipments. James B. Cahoon (Paper read before the N. Y. State Ry. Convention. Advocates rigid daily inspection, and suggests a plan therefor). Elec Wld–Sept. 19. 1600 w.

8276. Street Traction in France (From the *N. Y. Evening Post, Sept. 5.* Reviews the situation and the causes favoring and opposing electric, compressed air, and cable traction respectively). Elec–Sept. 16. 1200 w.

8279. New York Street Railway Association (A report of the annual meeting, with abstracts of communications and discussions). R R Gaz–Sept. 18. 2300 w.

*8298. Standards for Rating Apparatus. W. J. Clark (Abstract of paper presented to N. Y. State Street Ry. Assn. Suggestions upon the more thorough standardization of electrical railway apparatus). St Ry Rev–Sept. 15. 1200 w.

*8299. Selection of Motormen and Conductors (Summary of methods employed by various companies; compiled from correspondence). St Ry Rev–Sept. 15. 2300 w.

*8300. Trolley Parties and Party Cars (A compilation of correspondence from managers of various roads, describing their practice regarding this feature of operation). St Ry Rev–Sept. 15. 2200 w.

*8301. The Matter of Transfers. J. H. Stedman (Abstract from a paper read before the N. Y. State Street Ry. Assn. A discussion of the expediency of a liberal transfer system). St Ry Rev–Sept. 15. 1200 w.

*8302. Construction and Maintenance of Electric Street Railway Tracks. George H. Neilson (Abstract of paper read before the Penna. State Street Ry. Assn. A brief discussion of established points in city and suburban construction). St Ry Rev–Sept. 15. 2200 w.

*8303. Long Distance and Heavy Duty Electric Railways. F. W. Darlington (Paper read before the Penna. Street Ry. Assn. A discussion of established facts and mooted points as to general policy). St Ry Rev–Sept. 15. 4000 w.

*8304. How Can We Prevent Accidents and Increase the General Efficiency of Employés? W. W. Cole (Read before the N. Y. State Street Ry. Assn. Discusses as means of safety, principally the qualifications of employés, inspection of equipment, careful examination of schedule, and high standard of construction). St Ry Rev–Sept. 15. 1200 w.

*8305. The Use of Old Rails as Underground Conductors. F. O. Rusling (Read before the N. Y. State Street Ry Assn. Discussion of the advantages and limitations of the system). St Ry Rev–Sept. 15. 1200 w.

8316. Street Railways in the Empire State. G. Tracey Rogers (Address before the Street Railway Assn., reviewing notable features of the New York lines). W Elec–Sept. 19. 3000 w.

8360. Report on Rails for Street Railroads. C. L. Allen (Read before the Street Railway Assn. of the state of N. Y. (Recommendations for general specifications). Elec Rev–Sept. 23. 1000 w.

8382. Staten Island's Railway System (Illustrated description). Elec Eng–Sept. 23. 1500 w.

8385. Trolley Line between Lakes Erie and Ontario. Orrin E. Dunlap (Brief illustrated description). W Elec–Sept. 26. 600 w.

8392. The Efficiency of Railway Motors. William Baxter, Jr. (An article aiming to show

the superiority of electricity to compressed air for traction purposes). Elec Wld-Sept. 26. 2000 w.

8422. The Pole Gas-Motor Street Car. T. C. J. Baily, Jr. (Description of construction and trial of an experimental motor-car). Eng News-Sept. 24. 600 w.

8510. Compressed Air vs. Electric Motors. (Letters from Edward W. Serrell and Ira Harris, reviewing the comparative advantages and defects with conclusions favorable to compressed air). R R Gaz-Oct. 2. 2800 w.

8536. General Track Construction and the most Approved Method. C. Loomis Allen (Abstract of paper before the N. Y. State R'way Assn. advocating high carbon steel rails and giving recommended specifications for composition, with notes of discussion). W Elec-Oct. 3. 900 w.

8538. Willow Grove Park and Electric Road. Herman S. Hering (Illustrated description of a road and amusement park which has proved a successful investment). Elec Wld-Oct. 3. Serial. 1st part. 3300 w.

*8603. Liverpool Overhead Railway. S. B. Cottrell (Read before the British Assn. for the Adv. of Science. Describes construction, signals, extension, equipment, etc). Elec Rev, Lond-Sept. 25. 4400 w.

8648. Electric Traction on the Third Avenue "L" Road, New York (Illustrated description of the methods of operation to be introduced on the 34th St., branch). Elec Wld-Oct. 10. 1300 w.

Equipment and Equipment Maintenance.

8150. The New Express Engines of the North Eastern Railway, England (Brief description with drawings and details). R R Gaz-Sept. 11. 900 w.

*8157. The North Eastern Railway Company's Latest Express Engines (Description, details and sectional drawings). Ry Wld-Sept. 350 w.

*8170. Some American Locomotives (Brief note and illustrations of American engines built for Spanish American roads). Eng, Lond-Sept. 4. 150 w.

8262. Oil Burning Locomotives (Description of engine in use on the Pacific coast, with sectional drawings of fire box and oil-tank. Oil burning is said to be merely a question of economy not of mechanical success). Ry Age-Sept. 11. 700 w.

*8295. Locomotive for 2-ft. Gauge Railway (Sectional drawing and details of principal dimensions). Engng-Sept. 11. 600 w.

8420. 60,000-Lb. Box Car for the Baltimore & Ohio R. R. (Description with measurements and detail drawings). Eng News-Sept. 24. 600 w.

8427. Compressed Air in the Shops of the Missouri Pacific Railroad. H. N. Latey (Description of practice and illustration of devices). R R Gaz-Sept. 25. 1600 w.

*8514. Some Odd Locomotives Recently Turned out by the Baldwin Locomotive Works (Illustrations and very brief description of some unusual types for special duties). Loc Engng-Oct. 500 w.

*8515. Remodeling of 40,000-Lb. Cars (Brief description of a method of remodeling 40,000-lb. box cars into 50,000-lb. cars. Drawings of some of the details). Loc Engng-Oct. 1100 w.

*8528. The Use of Buffer Blocks with Vertical Plane Couplets (Brief citation of the overlooked advantages to be derived from their use). Am Eng & R R Jour-Oct. 800 w.

Maintenance of Way and Structure.

8272. Tie-Plates (Report of the Committee on Roadway, Am. Soc. of R. R. Supts., with correspondence. The report is highly favorable to the tie plate for safety and economy). Eng News-Sept. 17. 6500 w.

8274. Convention of the Roadmasters' Association of America (Report of convention, with special reports and discussions on facing point switches, ditching, rail joints, ballast, etc). Eng News-Sept. 17. 6500 w.

8277. A Modern Railway Span (Drawings and description of a typical span, with comment on the gradual assimilation of English and American types). Ry Rev-Sept. 12. 1200 w.

8437. Ballast Crushing Plant Illinois Central Railroad (Illustrated description). Ry Age-Sept. 25. 350 w.

Signaling.

8261. Signaling and Interlocking in Chicago (A description of the Chicago & Northern Pacific Plant at Grand Central Station). Ry Age-Sept. 11. 600 w.

8421. Block Signaling and Interlocking (Abstract of discussion at the meeting of the American Society of Railroad Superintendents, at Niagara Falls). Eng News-Sept. 24. 1400 w.

8438. The Electric Train Staff (Abstract of Mr. Charles Hansel's paper before the Am. Soc. of R'way. Supts., at Niagara Falls. Illustrated). Ry Rev-Sept. 26. 3000 w.

8440. Is the Switch and Lock Movement Safe? W. H. Elliott (A paper read before the Railway Signaling Club. The position taken is that the movement is reasonably safe when used in connection with the bolt lock). Ry Rev-Sept. 26. 1500 w.

8511. Interlocking at Paoli, Pa. (Brief descriptive account, with diagram, plan of rods and wires, etc). R R Gaz-Oct. 2. 700 w.

Transportation.

8152 Rapid Transit—Analysis of One Day's Traffic of the Manhattan Railway, New York City. Theodore Cooper (The analysis is very full, and is illustrated by tabular and graphic charts). R R Gaz-Sept. 11. 2500 w.

8296. Injunction Against Rate-Cutting (Summary of the petition in the new proceedings and of the order of Judge Speer granting the injunction). Ry Age-Sept. 18. 1000 w.

8426. The Economy of Express Trains on Urban Railroads. William Barclay Parsons (Strongly advocates the express system. Arguments based upon New York rapid transit experience). R R Gaz-Sept. 25. 2200 w.

8433. Interstate Commerce Commission Hearing at Chicago (Abstract of cases and evidence presented). Ry Age-Sept. 25. 1400 w.

8435. Handling of Switching Charges (Proposed method of disposing of these troublesome accounts). Ry Age-Sept. 25. 1200 w.

8436. Pooling of Freight Cars (Mr. Cavanagh's plans explained in answer to enquiries). Ry Age-Sept. 25. 900 w.

Miscellany.

*8123. Fast Trains as Related to Business Policy. H. G. Prout (Discussing the relation of increase in train-speed to increase in passenger-traffic). Eng Mag-Oct. 4300 w.

8151. Maine Railroad Commissioners Refuse an Electric Railroad Application (The application was opposed by a steam road, and the application was denied on the ground that public convenience did not require the new line. Abstract of the report is given, and editorial). R R Gaz-Sept. 11. 2800 w.

*8154. The Burgenstock Rack Railway (Description of a notable Swiss road). Ry Wld-Sept. 1400 w.

*8155. The Liverpool and Manchester Railway (Historical review, with illustrations of original line and equipment). Ry Wld-Sept. 1500 w.

*8166. An Egypto-Assyrian Railway as the New Overland Route to India. A. T. Fraser (A representation of the enormous importance to England of connecting Ismailia by rail with the head of the Persian gulf). Jour Soc of Arts-Sept. 4. 2000 w.

†8196. Indian Railway Policy (Criticism of the vacillating policy, alternating between government operation and company working under government guarantee, and recommendation of management under a few large companies). Ind & East Eng-Aug. 15. 2800 w.

8204. A Comparison of Three Locomotives—Two American and One English. M. McCabe (The comparison is based on scientific calculations from partially assumed data, and is very favorable to the American types, but strong emphasis is laid upon the necessity of greatly improving the steam locomotive). Age of St-Sept. 12. 900 w.

8273. Convention of the American Society of Railroad Superintendents). Brief report of annual meeting, with abstract of committee reports on electric locomotives, and tonnage rating of freight trains). Eng News-Sept. 17. 2000 w.

8278. The Effect of High Rates of Combustion Upon the Efficiency of Locomotive Boilers. W. F. M. Goss (Gives the result of experiments, with tables and charts. The most efficient action is shown to accompany the lowest rates of combustion, and the reasons given). R R Gaz-Sept. 18. 1700 w.

*8293. The Glasgow Central Railway (The first part sketches the projected enterprise and its territorial relations, with description of the plans adopted for station building. Sectional plans are given). Engng-Sept. 11. Serial. 1st part. 2500 w.

8297. The Motive Power of the Future (Takes the ground that with advancing improvement in mechanical applications, electricity will supplant steam, which, according to this article, has reached the limit of practicable perfection in the locomotive). Ry Age-Sept. 18. 1200 w.

*8306. The Railway Year in New Zealand (Tabulation and review of earnings, mileage, traffic, etc). Trans-Sept. 11. 1500 w.

*8311. The Snowdon Mountain Tramroad (Correspondence reviewing the accident, and discussing causes and preventive measures). Eng, Lond-Sept. 11. 3000 w.

8380.—$1. A Re-survey of the Williamsport Division of the Philadelphia and Reading Railroad. George D. Snyder (Abstract of a paper accepted by the Committee on Publication for filing in the library of the Society. The method used is explained and its advantages stated). Am Soc of Civ Engs-Sept. 1600 w.

8428. Train Accidents in the United States in August (Classified table with editorial comments). R R Gaz-Sept. 25. 3000 w.

*8430. Japanese Railways (Analysis and discussion of an official report by the British Sec'y. of Legation at Tokio. An impending boom is predicted, and English manufacturers urged to combat growing American influence). Engng-Sept. 18. 2500 w.

*8432. The Railways of New South Wales (A review of the year's results, revenues, expenditures and rates, with some general comment). Trans-Sept. 18. 1400 w.

8512. Telegraph Construction on English Railroads (Abstract of a paper by W. Langdon, read before the Inst. of Elec. Engs., summarizing English practice, and of the ensuing discussion). R R Gaz-Oct. 2. 1500 w.

8513. Some Speculations About the Economy of Locomotives Under a Variable Load (Formulæ, table and diagrams from Prof. R. C. Carpenter's paper before the A. I. E. E). R R Gaz-Oct. 2. 1200 w.

*8516. The Traveling Engineers' Convention (Brief report with abstract of reports and discussions). Loc Engng-Oct. 7000 w.

*8526. A Few Facts and Opinions on the Design of Express Locomotives (Notes of the London meeting of the International Congress, cited to show prevailing ignorance of American practice). Am Eng & R R Jour-Oct. 1500 w.

†8617. Statistics of Railways in the United States (Eighth annual report on the statistics of railways in the United States for the year ending June 30, 1895. Prepared by the statistician to the commission). 17500 w.

8618. The Aylmer Branch of the Canadian Pacific Railway Operated by Electricity). Description of the equipment and operation of a connecting link road handling considerable traffic). Elec Eng-Oct. 7. 700 w.

8622. A Russian Railway Official (Biographical sketch of Prince Michael Hilkoff, imperial minister of ways and communications of Russia, with considerable side light on Russian railway matters). Ry Rev-Oct. 3. 2500 w.

SCIENTIFIC MISCELLANY

General Fire-Fighting.

THIS was the title of a paper prepared by Mr. Simon Brentano of New York, and read at the seventeenth annual convention of the Massachusetts State Firemen's Association, held at Brockton, September 18. Mr. Brentano is a merchant, and in no way connected with any fire department, but he has made the subject of fire-fighting a special study. Captain Needham, of the New York fire department, who read Mr. Brentano's paper at the convention, spoke of Mr. Brentano as one "whose interest in all matters relating to fire-extinguishment was of the most enthusiastic kind, as a frequent and earnest observer of New York fires, and as a gentleman very popular with the New York fire department."

The paper is printed in *Fire and Water* (Sept. 26), from which we derive the following abstract.

Mr. Brentano regards the distinction between the earlier and more modern methods of fire-fighting as lying principally in the fact that, in the modern methods, the control of a fire is made paramount to mere extinguishment. In the earlier methods the aim was to extinguish rather than control. The modern method regards the extinguishment of a fire as incidental to control. What is here meant by control of a fire is defined as "its restriction as nearly as may be possible, under the varying circumstances attendant upon and surrounding each fire, to the actual point of origin, or to keep it within that boundary which the fire had attained at the time of the arrival of apparatus. In some instances this means that the fire will be confined to the room and to the actual incipient blaze which ignited a window curtain; in others, it will mean the complete destruction of the building in which the fire originated; again, in others, it may mean the ignition and destruction of neighboring and adjacent buildings. But at no time has the experienced fireman lost his sense of control, nor have his plans changed, except by reason of those changes forced upon him by the apparent gain of the fire over all control for the time being. But in such cases companies are assigned to new positions, the lessening points of danger abandoned, the more menacing position is strengthened, and that disposition is made in detail that evinces sagacity, the quick and ripened judgment of the fireman, and that throughout illustrates the underlying object to be achieved,—namely, the control of fire. Against what fearful odds the control is often won is familiar to you all. It must often have impressed itself upon your mind, reflecting over the changing conditions that have existed during the course of some of the fires at which you have performed duty, how the careful assignment of one company may have been the key-point, or, in other words, determined the control of a fire. The control of fire should not at any time be confused with the actual extinguishment of fire. I have seen fires far more destructive than the occasion warranted, by reason of the fact that the proper estimate was not placed upon the chief element attaching to every fire,—namely, a correct judgment as to its control. To illustrate this by familar example, I need only point out that many fires gain and cover an area larger than they should, because upon arrival the companies, or those in charge of them, fail to recognize that the original point of fire is beyond instant control; but, in the mistaken effort to extinguish this original source of fire, instead of keeping it in check, it permits the fire to extend. The inability to view a fire and to determine at once whether or not the greater effort should not be extended to surrounding risks rather than the immediate fire itself forms one of those errors of judgment in practice which have been, and will continue to be, a serious cause of unnecessary fire-

loss. Of course, the control of a fire, I need not say, should be effected with the greatest celerity possible. It is, of course, a simple and fundamental law of fire-extinguishment that the danger of destruction is lessened with each moment gained in the control. Most fires attain their maximum in relatively short time. I have timed several very serious fires, and I have estimated that they have reached their maximum danger-point in thirty-five to fifty minutes; after that time the fire was a receding one,—that is to say, the control over it was becoming manifest. A fire which one hour after its inception is burning as fiercely or as dangerously and shows no sign of abatement is a most serious fire and portends great danger,—of course, I except from this classification structures completely isolated, certain oil fires, and lumber fires,—but in the main the visible signs of gain should be present in thirty-five to fifty minutes. I have seen a very dangerous fire in a five-story building about fifty by seventy-five feet, where the fire originated on the third floor and at once assumed large proportions, controled in exactly fourteen minutes, although the actual duty of fire-extinguishment kept a sufficient number of companies busy for five hours subsequently."

As to fire-extinguishment the rule to be followed is to bring the "water to bear as nearly as possible to the actual seat of fire or combustion. . . . The most efficient use of water is when the stream is directed at a range as close as practical conditions will permit to the actual seat of fire." Mr. Brentano does not think that pressure can compensate for want of sufficient volume in fire-extinguishment. He seems to think, however, that pressure *per se* performs a valuable function in putting out a fire, but for this opinion he declares himself yet unprepared to assign a reason.

The Preservation of Data by Photography.

THE tedious work of hand-copying with a pen is a burden from which the civilized world has long wished relief. Copying presses, typewriters, and numerous processes for producing copies of script are in evidence of this desire. No better example of drudgery-work pure and simple, and utterly devoid of interest, could be found than the hand-copying of documents. Not only the mind is unexercised, but the body also, and to an active mind work of this sort is inexpressibly tedious.

In the collection of data scientific and professional men require a great deal of copying to be done, and, as, in writing formulæ, etc., it is not safe to trust the uneducated persons who usually do copying because they are incompetent for anything better, collectors find it necessary to do at least a fraction of the work themselves.

Mr. Reginald A. Fessenden, in *The Electrical World* (Aug. 22), describes a method for avoiding much of this drudgery by the use of photography. He says he has used this method for more than a year, and it proves so satisfactory that he now gives it out to the professional world as a great convenience to collectors of data. The use of photography has enabled him, not only to copy mathematical expressions, but diagrams and illustrations, with great rapidity and perfect accuracy.

Having first tried the library-card system, he found that many times he wished to copy down more matter than would go on one or two cards.

The method of photography, while it has been used, has not hitherto been reduced to a system. Mr. Fessenden, however, has devised a plan which he explains with the aid of half-tone engravings, which should be consulted in the original paper by persons who wish full details. Suffice it to say that the entire arrangement is attached to the desk of the user. An ordinary roll-top desk is shown in the illustrations. When it is desired to copy a page, it is placed on the flat surface of the desk, a sensitive plate is placed in a camera specially made for the purpose, having one and one-fourth inches focus, and a lens of one-fourth inch aperture, and working about twenty-five times as fast as the ordinary photographic lens with the usual stop, and taking in a wide angle. For objects over two feet away it needs no focusing. The operator then pulls downward a

chain attached to the camera to a distance corresponding to the size of the surface to be copied. The camera being thus brought into the proper distance, an exposure of ten seconds is given to the plate, and the plate-holder is put away till a convenient opportunity for development. The paper need not lie entirely flat on the desk, and requires very little care in its adjustment. Each plate is one and one-fourth by one and one-half inches.

On a plate of this size two thousand words may be printed so that they can easily be read by a small magnifying-glass, and five hundred words on such a plate may be read by a person of average eyesight without the aid of a glass. This seems an astonishing statement, but the author goes much further. The theoretical limit of reading without a microscope of the highest power is stated to be 150,000,000 words per square inch. The author tacitly admits that this is likely to stagger belief. We quote his concluding words:

"This is almost inconceivable, for three hundred volumes of a thousand pages each is a fair-sized library. But the only thing that till recently stood in the way of its practicability—*i. e.*, the coarseness of the grain of ordinary photographic plates—has been removed by Lippman in the beautiful experimental work by which he has made Rayleigh's proposed method of taking colored photographs by interference methods an accomplished fact.

"Even with a magnification of thirty diameters, instead of the six hundred which I have assumed in the previous calculations, one such volume would go on a plate one inch square. At this rate a box one foot cube would contain a library of 50,000 volumes, or 1,500,000 with the larger magnification.

"However startling this may seem, it is not impracticable, at least for the lower power mentioned; and it is well within the bounds of possibility that the scientific student of the future will do his book work with the aid of a small projection lantern and a library of small positives, purchased at a small fraction of the price now paid. The thing is infinitely more practical than the proposition, seriously made and received, that phonograph cylinders should take the place of books. It would take a man five years, reading at the rate of one hundred and fifty words per minute for ten hours per day, to utter the words which may be contained on a piece of glass one inch square, while, as regards ease of reference to a particular part of a work, there is no comparison. It would be an extremely easy matter, for instance, to arrange the mechanism of a plate containing a German dictionary so that, by the pressure of a couple of keys, the page commencing with any given letters would be thrown on the screen instantly."

There is much in this article to stimulate imagination and to indicate possibilities. And, though some of the statements made may seem extravagant to those not familiar with the use of the camera and microscope, they are, we think, all capable of verification.

The Underground River of New England.

WE find in the *Boston Journal of Commerce* (Sept. 26) an account of this remarkable underground stream, whose existence was first announced by the late Professor Denton of Somerville, Mass., some eighteen years ago, the statement being then received with very general incredulity. The discoverer said that this stream contained the purest water, and deemed it adequate to "supply all central New England for all time." The discovery was made by Professor Denton while searching for a supply of water sufficiently pure for use in a Foxboro (Mass.) hat factory for bleaching the material for fine summer hats.

The *Journal of Commerce* says that the discovery remained a secret with Professor Denton for a long time. On the south side of Foxboro there are several natural ponds, one of which is called "Witches' pond," from its peculiarities. This pond contains several springs of great size and has no visible outlet.

"Witches' pond was so named years ago, on account of the many peculiar noises heard there. At intervals there

were distinct rumblings beneath the surface. Superstitious persons were alarmed, and afraid to go near it. People who had no fear of ghosts watched the action of the water with interest. They always found the water icy-cold in summer, and it ever rolled and boiled. A water-pail would not cover the largest bubbles.

"The pond covers fifteen acres, and in winter ice forms there long before there are signs of ice on other ponds. Ice six inches thick forms on Witches' pond to every inch of ice on other ponds in the vicinity in the same length of time. Only a few years ago four men who were fishing through the ice narrowly escaped losing their lives. There was a sudden upheaval while the men were on the pond, and ice fourteen inches in thickness, that covered the peculiar lake, was thrown about. The men, having heard the internal rumblings, took warning and reached the shore just in time to avoid being precipitated into the boiling pond. Lily-pad roots as large as one's arm were brought to the surface at the same time.

"Professor Denton heard several stories about the pond, and out of curiosity made an investigation into the cause of the great boiling of the water which occurred at intervals. He tried to take soundings, but in several places he was unable to find the pond's bottom. Gases were detected rising from the pond, and he was led to believe that they issued from some distance below the surface. The water's remaining pure proved to him that the pond had an outlet as well as a source, and, as it was not visible, the investigation was all the more interesting.

"Pipes were driven about the well, and coal and blue clay were brought to the surface. Over one hundred feet below the level the pipe struck a ledge, and, after drilling the ledge on the south side of the pond, water was found. The water, when examined, was found to be purer than any other found in New England. Several wells were driven, and Professor Denton came to the conclusion that Witches' pond was an outlet for an underground river. It was when he told of his discovery that people laughed at him.

"The river located was one hundred and ten feet below the level. Above it was a covering of hard pan, and the bottom, twenty feet below the covering, was of rock. Professor Denton was of the opinion that there was no Witches' pond until there was an upheaval of the earth years ago, when the shelving rocks under and over the torrent were torn away. Aided by gases from the coal and other substances in the earth, a rent was torn, through which the water made its way to the surface.

"The streams in the vicinity of Foxboro are from a different water-shed. The underground river is believed to come from a glacial spring in the White Mountains of New Hampshire, or beyond. It is known that the city of Lowell struck the river only a few years ago, and from that day to this has had a fine supply of water. At the time the Lowell wells were driven no one had heard of the river flowing under New England from north to south. The underground current has been followed by wells through Attleboro, Dodgeville, and Hebronville, to Lebanon, where it swerves to the west and passes under Pawtucket falls on the Blackstone river, thence through Pawtucket southwesterly and under Providence, Cranston, Warwick, East Greenwich, and Wickford into North Kingston, and into the sea near Hazard's ledge."

Not far from the time that this river was discovered a large bleachery in Providence drove a well which yielded a never-failing supply of very pure water, doubtless from the same source as that of the water-supply of Lowell. The New Haven & Hartford railroad have struck the stream by wells at Pawtucket. The water is said to be better than ordinary spring water, and admirably fitted for use in steam boilers.

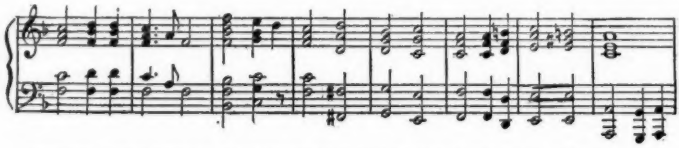
The Rivoire Music-Registering Apparatus.

THERE seems to be scarcely any limit to the resources of mechanicians. Let almost anything be required to be done mechanically, and there are plenty of mechanicians who will attempt the task, and some who will accomplish it. Among

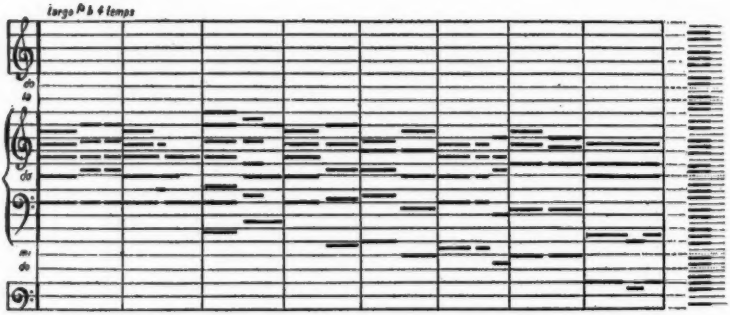
the ingenious mechanisms of modern times (not less ingenious because it is simple) is the music-recording apparatus herewith illustrated. One of the cuts represents the mechanism employed; the other shows the notation of which the interpretation is shown superimposed. Those who read music will find very little difficulty in reading the record of the performance. A musician to whom we showed it after explaining the principle of notation had no difficulty in reading it at sight.

We condense the description from an article reprinted in *Scientific American Supplement* (Oct. 3) from *L'Illustration.*

"If the composer places his finger upon a key, the pressure that he exerts actuates the rod, B. A lever, C, gives another steel rod, D, parallel with the first, an up-and-down motion. To the extremity of D there is adapted a transmitting rod, E, that gives an up-and-down motion to a rod, F, which is provided at its extremity with a wheel, M, that is always kept inked by an appropriate arrangement. A pressure upon the key gives an up-and-down motion to the wheel, M, through the series of rods and levers. A clockwork movement unwinds, at the uniform speed of fifty inches a minute, a band of paper



FIRST MEASURE OF THE RUSSIAN NATIONAL HYMN.



NOTATION OF THE ABOVE MUSIC UPON THE REGISTERING APPARATUS.

"The apparatus is inclosed in a wooden box under the keyboard. Under each key it suffices to form an aperture in the bed of the piano for the passage of a rod that transmits the musical thought to a pen through the mechanism described. Such preparation permits of applying the apparatus to all pianos.

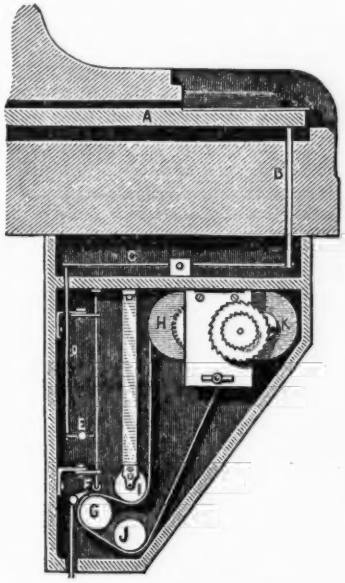
"Suppose the composer is at the piano; a simple ungearing starts the apparatus, and causes the rod to rise and abut against the key. If the rod is lowered, the piano returns to its normal state, and the apparatus is at rest.

wound upon the roller, K. This band passes over the cylinders, G, I, J, the object of which is to put it in contact with the pen, F, when the latter is actuated. Then, after it has received the signs thus automatically inscribed upon it, the band winds around the receiving cylinder, H, whence it may be unwound in order to read or criticise the finished improvisation. In measure as it unwinds, the band is regulated mechanically by a series of dashes in the direction of the motion. The interrupted dash of the center represents the do that separates the key of sol

from the key of fa. The other dotted lines, la and do in the key of sol, and mi and do in the key of fa, are register marks.

"The reading of this new method of musical inscription is done in about the same way as that of the music that we ordinarily decipher, each note occupying in the two writings an identical place upon the stave; only, flats and sharps are determined by the position that they occupy, and not by the aid of a particular annotation, and they always find a place in the interlines. Every note touched will be inscribed upon the band of paper in the form of a dash whose length will determine the rhythm. The reading of the inscription thus obtained is easy to a skilled musician. Those not skilled may use a small movable cardboard keyboard, proportioned to the width of the band of paper, to cover each note stenographed upon the band. But the use of this device will soon become useless to whoever has familiarized himself with the operation of the apparatus. In fact, he will soon learn to read the open band, and will disdain the use of a measure bar, which is maneuvered with the left foot and which permits of the decomposition of the musical inscription into measure and time.

The band unwinds at the speed of fifty inches a minute, and, being two hundred and forty-six feet in length, will last an hour. The clockwork movement that actuates the mechanism needs to be wound up every twenty or thirty minutes.



MUSIC REGISTERING APPARATUS.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

8137. The Artistic Element in Engineering. Frank O. Marvin with Editorial (An Address delivered before the Am. Assn. for the Advancement of Science. A plea for more attention to the æsthetic aspect of engineering in the furtherance of which, it asserts, that the American engineering schools are doing little or nothing). Eng News-Sept. 10. 5300 w.

8149. A Quarter Century of Progress in Engineering Education. Robert Fletcher (Abstract of paper read before the Soc. for the Promotion of Engineering Education. Historical and critical essay). R R Gaz-Sept. 11. 3400 w.

8189. Sir John Millais. S. Beale (Review of the work of this great painter). Am Arch-Sept. 12. 2000 w.

*8190. On the Röntgen Rays. G. G. Stokes (An extract from an address to the Victoria Inst. A review of what is known regarding these rays, and the previous work which gradually led to them). Nature-Sept. 3. 4200 w.

†8231. Baths for German Miners. H. F. Merritt (A general description of bathing facilities supplied to German miners). San-Sept. 1000 w.

8235. Clocks Provided with Automatons) (Illustrated description of ancient and modern examples). Sci Am Sup-Sept. 19. 1800 w.

8237. The Schools of Ancient Greece. Alice Zimmern in *Leisure Hour* (Illustrated description). Sci Am Sup-Sept. 19. 5000 w.

8 38. The Inspection and Sanitary Analysis of Ice. Charles L. Kennicott (Method and apparatus described and illustrated). Sci Am Sup-Sept. 19. 2800 w.

8242. Manufacture, Use and Abuse of Dynamite. H. A. Lee (Abstract of a paper by the Commissioner of Mines of Colorado. Different

We supply copies of these articles. See introductory.

kinds of explosives having nitro-glycerine for a base are treated). Can Eng–Sept. 1800 w.

*8244. Canals and Their Impurities. H. Ward (Read before the Staffordshire Sanitary Inspectors' Assn. The subject is treated with reference to the sanitation of canal waters). San Rec–Sept. 4. Serial. 1st part. 1600 w.

8263. The Columbia River Salmon Fisheries (Illustrated description). Sci Am–Sept. 19. 1600 w.

8281. Baths. G. Mendizabal (Read before the American Public Health Assn. Uses, abuses, benefits and dangers of baths. Promiscuous bathing in a common bath-tub is dangerous unless the greatest cleanliness in the care of bath-tub, towels, brushes, etc., is observed). San Plumb–Sept. 15. 1800 w.

*8291. Technical Education (English and American technical schools compared briefly). Engng–Sept. 11. 1700 w.

*8334. The Great Seismic Wave of Japan (Summarizes the particulars of this occurrence, and gives causes which have been assigned for its creation; also refers to waves of a similar character that have occurred on former occasions and in other localities). Nature–Sept. 10. 2200 w.

*8335. Application of Röntgen Rays to the Soft Tissues of the Body. John Macintyre (Illustrated account of examples obtained in this branch of the art). Nature–Sept. 10. 2800 w.

†8351. New Staffordshire Pottery Kilns (Illustrated description). Cons Repts–Sept. 1800 w.

†8353. Germany's Importation of United States Cotton (Importance of Germany as a consumer of American cotton. Faults in baling illustrated). Cons Repts–Sept. 1000 w.

8371. Apparatus for the Manufacture of Acetylene Gas (Illustrations and brief descriptions of some of the more prominent apparatus in use). From *Le Genie Civil.* Sci Am Sup–Sept. 26. 2000 w.

8395. The Fire Alarm Telegraph, General History and Latest Improvements. William Brophy (A general review of progress from 1845 to date). Fire & Water–Sept. 26. 5300 w.

8396. General Fire-Fighting, with Particular Reference to the Advisability of the Establishment of a Fire School or College in Connection Therewith. Simon Brentano (Fundamental laws of fire extinguishing. Suggestion for a school of instruction in fighting fire). Fire & Water–Sept. 26. 2000 w.

*8411. Röntgen Ray Hypotheses (The theories most in favor at the present time). Elec Rev, Lond–Sept. 18. 1200 w.

8453. Artesian Wells (Abstract of a paper by A. A. de Bonneville, contributed to the *Stevens Indicator* for July. Definition of an artesian well, the conditions necessary for such wells, and various methods for sinking or boring them). Eng Rec–Sept. 26. 1800 w.

8456. An Underground River (Remarkable subterranean stream of pure water flowing from the White Mountains, first discovered by the late Prof. Denton). Bos Jour of Com–Sept. 26. 1500 w.

*8459. Technical Education (Editorial in which the so-called "bogie" of German competition with English industry is treated as based largely upon misrepresentation). Eng, Lond–Sept. 18. 1800 w.

*8460. Monsted's Margarine Factory, Southall (Illustrated description of ammonia condensers used in this establishment). Eng, Lond–Sept. 18. 800 w.

*8506. Transmission and Photometry of X-Rays. Antonio Róiti (Investigations on X-ray phenomena). Elect'n–Sept. 18. 1800 w.

*8507. On Tubes for Producing X Rays. Augusto Righi (Explains an easy and speedy method of constructing tubes for X rays with which remarkable effects may be obtained). Elect'n–Sept. 18. 600 w.

8537. Röntgen-Ray Tubes. W. M. Stine (The writer states that no standard form of tube has yet been evolved nor is one needed. He gives minute details for the construction of glass-impact tubes, and shows that by the method of reversal it is possible to completely restore a tube to its original condition without heating or re-exhausting. Also discusses metallic-impact or focusing tubes, and their working). Elec Wld–Oct. 3. 2200 w.

*8567. Technical Education. Sidney H. Wells (A critique upon an editorial on this subject which appeared in *Engineering*, Sept. 11, maintaining that the editorial referred to gives a false impression and does a grave injustice to a great and important educational movement). Engng–Sept. 25. 1700 w.

†8585. Modern Theories of Fermentation, with Notes on the Morphology and Culture of Yeasts. Dr. Francis Wyatt (A dissertation upon germs and the life history of micro-organisms). Jour Fr Inst–Oct. Serial. 1st part. 5800 w.

†8588. On a New Process for the Manufacture of White Lead. William Tatham (A brief résumé of pre-existing methods is followed by a description of the new method, which is extremely simple and gives a product almost exactly like the best Dutch white lead). Jour Fr Inst–Oct. 1800 w.

8643. The Louisiana Sulphur Wells. J. B. Frauckhauser (Illustrated description of the wells and of Frasch's method of pumping up sulphur liquefied by heat). Sci Am–Oct. 10. 1000 w.

8646. Some Recent Röntgen Ray Work. Elihu Thomson (Illustrated description). Elec Wld–Oct. 10. 800 w.

†8654. The India-Rubber Business in Trenton. W. H. Dunbar (A résumé of the rubber industry in this city). Ind Rub Wld–Oct. 10. 1700 w.

†8655. India-Rubber in British Official Reports (A comprehensive array of India-rubber statistics). Ind Rub Wld–Oct. 10. 1800 w.

†8656. The Rubber Tire Association (An important organization, embracing most of the manufacturers of tires in this country). Ind Rub Wld–Oct. 10. 800 w.